STATUS OF MINERAL RESOURCE INFORMATION FOR THE OSAGE INDIAN RESERVATION, OKLAHOMA

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SUMMARY AND CONCLUSIONS

Petroleum, natural gas, limestone, dolomite, sandstone, clay, and sand and gravel have been produced commercially on the Osage Indian Reservation. Production of these commodities will probably continue, but sandstone may be produced only in minor quantities.

Potential exists for producing dolomite, and possibly limestone, for chemical and metallurgical purposes although all limestone and dolomite production to date has been used for crushed stone. Clay deposits on the reservation have been used as a source of materials for brick manufacture; however, some clay occurring on Indian land is suitable for artware as well as structural clay products.

INTRODUCTION

This report was prepared for the Bureau of Indian Affairs by the U.S. Geological Survey and the Bureau of Mines under an agreement to compile and summarize available information on the geology, mineral resources, and potential for economic development of certain Indian lands. Sources included published and unpublished reports, and personal communications. There was no fieldwork.

Area, Location, and Land Status

The Osage Indian Reservation (Figure 1) includes approximately 99.99 percent of Osage County, Oklahoma. Tribal headquarters and the Bureau of Indian Affairs (BIA) offices are in Pawhuska, the Osage County seat. The county is an irregularly-shaped area that is bounded on the north by the State of Kansas, on the west by Kay and Noble Counties, on the south and southeast by Pawnee and Tulsa Counties, and on the east by Washington County. The Arkansas River marks the boundary between most of Kay and Noble and Pawnee Counties and Osage County.

Osage County includes about 1,470,559 acres, but Indian-owned surface land, according to the U.S. Department of Commerce (1974, p. 463), amounts to 217,639 acres, of which 216,994 acres are allotted lands, and only 645 acres are owned by the tribe. According to tribal officials, the Osage tribe owns all mineral rights, both surface and subsurface, in the county except for 1,481.4 acres (Table 1).

The U.S. Department of Commerce (1974, p. 463) placed the population of the Osage Tribe at 3,369 in November, 1972. The Department of Commerce Census of Population for Oklahoma (1970) listed the population of Pawhuska as 4,238; however, much of the city population is non-Indian. The Osage Agency (BIA) at Pawhuska now estimates the Osage Tribe to number about 10,000, but lacks current data as to how many live on the reservation.

Tulsa, located southeast of the reservation and in part sprawling into Osage County, is the largest city in the region with a population of about 330,000. Other population centers in and near the reservation include Barnsdall (2,247), Bartlesville (29,683), and Ponca City (25,940) (U.S. Dept. Commerce, 1970). Oklahoma City (366,000) is about 100 miles to the southwest.

Access by road is good. The main east-west highway is U.S. 60 and leads from Bartlesville on the east to Ponca City on the west, passing through Pawhuska. State highway 99 goes from Cleveland on the south through Hominy to Pawhuska, connecting with U.S. 60. Various state and county roads afford access to nearly all other parts of the reservation.

Three railroads pass through the reservation. The Missouri Kansas-Texas Railroad crosses the southeastern part connecting Bartlesville, Hominy and Cleveland, the Texas and Pacific Railroad connects Pawhuska, Barnsdall, and Skiatook with Tulsa, and the Atchison, Topeka, and Santa Fe (AT &SF) connects Burbank and Fairfax, on the west, with Oklahoma City.

The Port of Catoosa, a few miles east of Tulsa, provides waterborne transportation to the Gulf of Mexico via the Verdigris, Arkansas, and Mississippi Rivers.

TABLE 1

Areas in Osage County Where the Osage Tribe Does Not Own the Mineral Rights

Location (section, township, and range)	Number of acres
Part of S ½ sec. 4 and N ½ sec. 9, T. 25 N., R. 9 E.	535.5
NE ¼ sec. 18, T. 24 N., R. 11 E.	160.0
S ½ NW ¼ sec. 7 and N ½ SW ¼ sec. 7, T. 24 N., R.6 E.	150.6
Part of sec. 1, T. 22 N., R. 8 E.	160.0
SE ½ sec. 29, T. 28 N., R. 7 E.	160.0
NE ¼ sec. 8, T. 25 N., R. 9 E.	155.3
Part of S ½ sec. 34, T- 25 N., R- 7 E-)	
NE ¼ NW ¼ sec. 3, T. 25 N., R. 7 E.)	160.0
Total	1,481.4

Source: BIA Records

Past Investigations

The Osage Indian Reservation has been the focus of geologic interest since 1896 when the first oil-and-gas lease was obtained. The first completed well was drilled in 1897. Early geologic reports by Heald (1916, 1918), White and others (1922), and Beckwith (1928) were instrumental in establishing the geologic framework of the area. Many publications have dealt with the geology of the area, most notably the work of Bass and others (1942), which includes detailed surface and subsurface data. The reports by Bass and others include a two-inch-to-the-mile series of 16 maps that cover the entire reservation showing wells drilled, producing zones, and structure contours on the Oswego lime (Fort Scott Limestone) and a similar series of 16 structure contour maps on the Mississippian. An update of the two 16 map series was done by Wagoner (1968 and 1970) and is available for examination in the BIA office in Pawhuska; these maps are kept current with all drilled wells posted on a regular basis. The Tulsa Geological Society published a Symposium on the Arbuckle (1964) and a Symposium on the Simpson (1965); both volumes contain regional and local papers that deal directly with the Osage Reservation.

Surface geologic maps are available for nearly the entire reservation and are shown on Figure 2. Many of these reports are in the form of unpublished thesis work, available for examination in the Oklahoma Geological Survey, University of Oklahoma Library in Norman, Oklahoma. In addition, there are many subsurface maps of diverse nature dealing with nearly every segment of the geologic column, though most are concerned with Pennsylvanian strata.

Publications dealing with specific topics covered in this report are cited in the following text. In addition, many other papers of interest not cited are included in the list of references for the interested reader. The list is not intended to be exhaustive; rather, the list is a good starting point for an intensive geologic study of the reservation. The entire reservation is covered by U.S. Geological Survey 7.5- or 15-minute topographic quadrangles as shown on Figure 3.

Other maps published by the U.S. Geological Survey include an Oklahoma base map and an Oklahoma geologic map, both on a 1:500,000 scale. All maps listed as published by the U.S. Geological Survey may be ordered from the U.S. Geological Survey, Branch of Distribution, Central Region, Box 25286, Denver, Colo. 80225.

Another source of maps is the Oklahoma State Highway Department's series of County Road Maps. Requests for such maps should be addressed to the State of Oklahoma Department of Highways, Reproduction Branch, 200 NE 21st, Oklahoma City, Okla. 73105.

Aerial photographs of the area can be obtained from the U.S. Department of Agriculture, Agricultural Center Office Building, Still water, Okla. 74074. Satellite imagery of the reservation may be obtained from the U.S. Geological Survey, EROS Data Center, Sioux Falls, S. Dak. 57101.

Geomorphology

The Osage Indian Reservation is an area of low relief with low rolling tree-covered hills and broad open grass-covered plains. Pennsylvanian shale, sandstone, and limestone are exposed throughout the reservation and have a regional west dip of 1°-2°. The western portion of the area, west of a north-south line through Pawhuska, is the type area of the Pawhuska rock plain (Melton & Ham, 1939), an erosional surface of extremely low relief at an elevation of 1,000 to 1,050 feet that includes east central Oklahoma and extends northward into Kansas and eastward into Missouri and Arkansas. The eastern portion of the reservation is "a rolling plain between 700 and 900 feet with a few incised valleys to about 650, and a few hilltops to about 1,050 feet. The latter stand along the western edge of the area, and may be east-lying remnants of the Pawhuska erosion surface." (Tanner, 1956, p. 11).

North-northwest-trending subdued cuestas are common throughout the reservation. The cuestas are better developed and more abundant in the eastern portion of the reservation because of the abundance of well-developed sandstones that crop out on the Pawhuska rock plain and are readily eroded in comparison with the sandstones to the east.

GEOLOGY

The Osage Indian Reservation is located on the west flank of the Ozark uplift near the Nemaha Ridge (Figure 4). Paleozoic strata at the surface and in the subsurface dip gently westward off the uplift and include sandstone, limestone, shale, and dolomite about 4,500 feet thick. Stratigraphic and structural traps on the Osage Reservation include one of the most famous and largest petroleum occurrences in the world, the Burbank field with an ultimate recovery of approximately 500 million barrels of oil (Halbouty and others, 1970). The Precambrian basement of igneous rocks underlies an irregular erosional surface on which the Paleozoic rocks were deposited.

Precambrian Rocks

The Precambrian basement rocks include the Washington County volcanic group, Spavinow granite group, Osage County microgranite, and Central Oklahoma granite group (Figure 5) (Denison, 1966). Rhyolite porphyry with relict welded tuff textures is the dominant rock type in the Washington County volcanic group. The Spavinow granite is comprised chiefly of micrographic granite porphyry that appears to have intruded the Washington County volcanic group. The Osage County microgranite appears to intrude the volcanic rocks and is a hypabyssal intrusive rock. Youngest of the basement-rock series are the medium- to coarse-grained rocks of the Central Oklahoma granite group. Radiometric ages of 1,240 m.y. on feldspar and 1,150 m.y. on a whole rock sample were obtained from the Osage County microgranite and 1,190 m.y. on a whole rock sample from the Washington County volcanics very close to the microgranite-volcanic group contact (Denison, 1966).

The Precambrian basement surface is an irregular feature with more than 2,500 feet of relief in Osage County, having a broad, regional westerly slope from less than -1,000 feet at Bartlesville to more than -3,500 feet near Ponca City (Figure 6). A series of domes extends northwesterly from Tulsa across the county and have up to 1,200-1,300 feet of relief between structures. A west-plunging positive feature extends to the west from Bartlesville and intersects the dome trend northwest of Pawhuska.

Paleozoic Rocks

Northeastern Oklahoma is located on the stable North American craton and received a relatively thin sedimentary record of Paleozoic strata about 5,000 feet thick. The area contains no record of Mesozoic or Cenozoic deposition, except for some late Cenozoic gravel deposits related to Pleistocene glaciation and erosion. Paleozoic strata in northeastern Oklahoma record four marine advances and retreats across the region from south to north and back again. Each advance and retreat is considered as one event and is separated from succeeding events by regional unconformities that mark times of widespread non-deposition and (or) erosion. The strata of each event are major stratigraphic units called sequences. Erosion may completely remove rocks of one or more sequences from a small or large area, if the rocks were in fact deposited there, prior to the next marine advance. This results in the deposition of relatively young rocks on much older rocks with a complete lack of information for intervening events. The following discussion deals with each sequence in their order of occurrence and the rock formations constituting the sequences (Figure 7).

Cambrian-lower Ordovician Sequence

Cambrian seas first invaded the area in Late Cambrian time, encroaching on a surface of moderate relief. Basal formations are the "granite wash" and Lamotte-Reagan Sandstone. The "granite wash" is very local in distribution and probably represents reworked lag gravel deposits. It is typically encountered "overlying basement rocks near the crest or on the flanks of the Precambrian highs" (Reeder, 1977, p. 181). The Lamotte-Reagan Sandstone is the more common basal Paleozoic unit and is a fine, well-sorted rock that is time-transgressive, ranging from Late Cambrian to Early Ordovician in age, being younger where it laps up onto the Precambrian highs. Thickness of the "granite wash" is generally about 18 feet, though it locally is up to 46 feet thick and the Lamotte-Reagan Sandstone is usually 20 to 40 feet thick but ranges up to 66 feet in thickness (Reeder, 1977, p. 181).

The Arbuckle Group, commonly referred to as the "siliceous lime" in this area, includes interbedded and intertongued limestone, dolomite, and sandstone units that are divided into six or seven formations (Reeder, 1977; Harlton, 1964). Arbuckle rocks range in age from Late Cambrian to Early Ordovician and are zero to about 1,200 feet thick (Figure 8). Lower Ordovician Arbuckle strata were generally the first to lap over and completely cover the Precambrian highs. Post-Arbuckle erosion uncovered Precambrian rocks on at least six highs (Figure 8). Most Arbuckle oil and gas production comes from upper Arbuckle formations that are draped over Precambrian highs, the draping probably due more to differential compaction than to structural uplift of the highs. Some of the porosity at the top of the Arbuckle is due to weathering during post-Arbuckle time prior to Middle Ordovician deposition.

Middle Ordovician-Lower Devonian Sequence

The Middle Ordovician Simpson Group is the basal, and only, unit of this sequence on the reservation. It forms a thin northeastward-tapering wedge that ranges in thickness from about 200 feet on the southwest to zero along a northwest-trending line that passes near Pawhuska (Figure 9). The rocks consist of a basal sandstone (Burgen sand), a middle green shale and sandstone and locally dolomite (Tyner formation), and an upper sandstone (Wilcox sand). These units represent several small advances and retreats of Simpson seas across the area. Upper Ordovician, Silurian, and lower Devonian units of this sequence were probably deposited here also, but were stripped by pre-Late Devonian erosion that beveled the region to a surface of exceedingly low relief.

Middle Devonian-Mississippian Sequence

Middle Devonian seas invaded the area from east to west washing across gently southwest-dipping Arbuckle and Simpson strata, reworking Simpson sands to form the Middle to Late Devonian Misener Sandstone, the basal unit of this sequence. The Misener seldom exceeds 20 feet in thickness and is present only along the southwestern part of the reservation and in a small patch northwest of Bartlesville (Amsden and Klapper, 1972). The Late Devonian-earliest Mississippian Woodford (Chattanooga) Shale, a black carbonaceous fissile rock, is gradational with and overlies the Misener. Distribution and thickness of the Woodford is irregular, the shale being present throughout most of the reservation, thinning onto, and commonly being absent over, pre-Late Devonian topographic highs. Thickness of the Woodford ranges from zero to about 75 feet, generally being less than 50 feet.

The Lower Mississippian Mississippi lime overlies the Woodford Shale and is present throughout the reservation, ranging in thickness from about 100 to 400 feet. Limestone, in part dolomitic, and cherty limestone are the dominant lithologies. The base of the lime is a fairly planar surface on the nearly flat top of the Woodford; locally the lime rests on Arbuckle and Simpson rocks. Post-Mississippi lime erosion formed on irregular surface with relief locally in excess of 100 feet (Cruz, 1968). Production from the lime is typically at or near its top and is due primarily to hydrocarbon entrapment in porosity formed by surface or near-surface weathering.

Pennsylvanian-And-Younger Sequence

Several episodes of large-scale folding and faulting during Early and Middle Pennsylvanian time resulted in the formation of the Ouachita, Arbuckle, and Wichita Mountains along the southern edge of Oklahoma (Figure 4), while little deformation occurred to the north. The Nemaha Ridge was uplifted during this time and extended northward from the Arbuckle Mountains separating the Anadarko Basin on the west from the Arkoma Basin on the east. The Osage Reservation lies east of the Nemaha Ridge and was part of a stable shelf that sloped gently southward into the Arkoma Basin. Middle and Late Pennsylvanian seas advanced northwestward across the Osage country several times, with numerous minor fluctuations, inundating major drainage systems flowing southeastward between the Nemaha Ridge and Ozark uplift into the Arkoma Basin. This interaction of marine and river-delta deposition left a complex record of marine sandstone and limestone intertongued with irregular-shaped sandstone lenses encompassed in a northward-tapering wedge of shale.

The Mississippian "chat" is the basal unit and consists chiefly of conglomerate derived from the underlying Mississippi lime. The "chat" was deposited in an irregular channel system and varies rapidly in thickness from zero on topographic highs to more than 100 feet in deep channels. An isopach of the "chat" directly reflects the topography cut on the Mississippi lime as the "chat" has a fairly flat top (Cruz, 1968).

The first marine advance and its interaction with a large delta complex formed the world-famous Bartlesville (Figure 10), and Burbank (Figure 11) sands, the major producing sands in the area. Sandstone bodies, commonly referred to as "shoestring" sands, are up to about 15 miles long, several miles wide, and 200 feet in thickness. Sedimentation began in the southeast and progressed northwestward, forming successively younger deposits in that direction. The Bartlesville sand is older than the Burbank sand, both occurring in the Cherokee Group, which includes several other sands, limestones, and local coal beds. Many studies have been made of this interval and are too numerous to list here. Some of the studies include Visher (1968b), Visher and others (1971), Baker (1962), Bass (1936), Bass and others (1937), Oakes (1953), and Sands (1929).

Successive cyclical deposition continued throughout Pennsylvanian time forming the remaining rock units present in the area. Shale, sandstone, and limestone are the dominant lithologies. Hydrocarbon production is chiefly from small shoestring-sand units.

The Pennsylvanian-Permian boundary was generally placed at the top of the Brownville Limestone, a thin unit that outcrops near Fairfax, on the west side of the reservation, and strikes north-northeast. However, the Oklahoma Geological Survey now considers the Pennsylvanian-Permian boundary to be at the top of the Herington Limestone, a unit that occurs outside the reservation (Bellis and Rowland, 1976). Their usage is followed in this report.

Structure

Structures on the Osage Reservation include broad open folds and en echelon normal faults. The folds occur in two arcuate belts that trend north-northeast as seen on a structure contour map of the Oswego lime (Figure 12). In addition, three weakly defined northwest-trending belts are outlined by Bass (1942, plate 17). Dips on the flanks of the structures increase with depth, especially in the Cambrian and Ordovician strata, a common occurrence on folds in the mid-continent region. This indicates that these structures grew throughout much of Paleozoic time, at least in a sporadic fashion. It is likely that some of the "folding" is the reflection of differential compaction across earlier highs.

The enechelon normal faults occur in north-northeast- trending zones that lie within the north-northeast-trending fold belts (Figure 13). The individual faults trend chiefly N. 20° to 45° W. within these zones. They have less than 50 feet of displacement at the surface, in general, and seldom are more than two miles long (Bass, 1942, p. 379-380; Tanner, 1956). Displacement decreases with depth and it appears that rocks as old as the Oswego lime are not cut by the faults (Bass, 1942, p. 380). The en echelon fault zones are part of a major system that trends north-northeast across Oklahoma from the Arbuckle Mountains through this area.

Folding of the rocks appears to have occurred during much of the Paleozoic with faulting having taken place late in the history of the area. Bass (1942, p. 380) indicates that the faulting is not related to individual folds and points out that it probably "occurred long after the folding." The extreme coincidence of the en echelon normal-fault belts with the fold belts indicates that the two are closely related genetically and that the faulting may well have occurred at the same time as the latest folding event, but was restricted to a near-surface phenomenon.

Seismic Activity

Seismic activity in northeastern Oklahoma is very sparse and recorded earthquakes generally have been of low intensity. The Oklahoma Geological Survey is currently establishing a network of seismometers in the state (Luza, 1978). Earthquakes detected through 1977 show a northeast-trending belt of small magnitude events extending from El Reno, west of Oklahoma City, towards the Osage Reservation, but none have been recorded within the reservation (K. V. Luza, personal comm., 1978). The occurrence of a destructive earthquake on the Osage Reservation is highly unlikely.

MINERAL RESOURCES

Mineral production on the Osage Reservation began immediately after the discovery of oil in 1897. Petroleum and natural gas have been produced continuously since that time. Other commodities recovered from the reservation include limestone, sandstone, dolomite, clay, and sand and gravel. No metallic minerals are known to have been produced.

Energy Resources

Production of oil and natural gas from Osage County fields probably will continue, but at a decreasing rate, for many years. Coal occurs on the reservation but only in minor quantities (Trumbull, 1957). Several radioactive anomalies have been noted and described, but no significant uranium deposits are known.

Petroleum and Natural Gas

Oil was discovered on the Osage Reservation in October 1897, by Edwin B. Foster, in NW ¼ SW ¼ sec. 34, T. 27 N., R. 12 E. Production was 20 barrels (bbl) per day from the Bartlesville Sand. Foster had leased the entire county, and in 1902 he formed the Indian Territory Illuminating Oil Co. (ITIO), which subsequently became part of Cities Service Oil Co. of Tulsa. In 1916, the Department of the Interior broke up Foster's blanket lease and opened the area for auction.

Since 1897, at least 128 quarter sections have produced over 1 million bbl of oil each, and many more have produced one-half million or more. Total cumulative oil production from fields within Osage County between October 1897 and January 1977 was slightly in excess of 1.26 billion bbl. According to the Pawhuska Daily Journal-Capital (Sept. 29, 1972, p. 8G), royalties, bonuses, and lease rentals have returned about one-half billion dollars to the Osage people.

Altogether, about 34,000 wells have been drilled in Osage County, and about 10,000 still are producing. The average production of oil per well is about 3 bbl per day, but production ranges from less than 1 bbl to about 100 bbl per day. Much of the oil produced today is by secondary recovery methods.

Natural gas production from the reservation ranges between 25 and 35 million cubic feet (MMcf) per day. Gas production between June 1977 and October 1977 was about 7.9 trillion cu ft, and increase of 3.8 trillion cu ft over the same period in 1976. Gas production is seasonal, depending on demand.

The average drilling depth per well in Osage County is about 2,200 feet, and the success ratio for well completion during 1975 was 76.8 percent. Figure 14 shows the location and extent of oilfields in Osage County, and Table 2 lists the names and locations of the oilfields. Figure 15, Figure 16, and Figure 17 show the distribution of some of the oilfields that derive production from certain stratigraphic units--the Arbuckle group (Figure 15), the Burgess sandstone-Mississippi lime interval (Figure 16), and the Bartlesville sandstone (Figure 17).

As of April 1, 1976, 1,153,988 acres were under lease in the county, including 625,135 acres under oil lease, 482,700 acres under gas lease, and 46,153 acres under both oil and gas lease. It should be noted, however, that much of the acreage under oil lease still can be leased for gas and that much of the acreage under gas lease still can be leased for oil.

Leases are auctioned four times per year and are assigned on a quarter-section basis. Usually the quarter sections that are auctioned are nominated by the prospective lessee, but occasionally the tribe nominates areas. Recent leases have been awarded for as little as $800.00 for a quarter-section oil lease and for as much as $50,000 for a quarter-section oil and gas combination lease. Table 3 shows the price range of recent sales of quarter-section leases in the three categories. Tribal royalties on oil and gas are 16.66 percent of the value.

Oil resources on Osage land are sufficient to last for the foreseeable future, although production may continue to decline. Production by secondary recovery methods probably will increase in the future. Gas production has increased recently owing to increased prices for that commodity. This trend probably will continue, at least for the next few years.

Nature of Hydrocarbon Traps

Hydrocarbon occurrences are controlled by stratigraphic pinchouts of sands, folds, porosity-permeability traps in limestone and dolomite, unconformity traps, and a combination of these. The dominant trap in the area is the shoestring-sand pinchout of deltaic origin, such as the Burbank and Bartlesville sands. This type of trap is typical of all of the Pennsylvanian deposits. Modifications are to be found on folds where the sands have structural closure in addition to their "shale closures." Bass (1942, p. 380-387) discusses these relationships in more detail.

TABLE 3

Price Range of Recent Sales of Quarter Section Oil and Gas Leases on the Osage Reservation

Lease Type	Low*	Average*	High*
Oil	$ 800	$ 5,000	$ 45,000 - 50,000
Gas	450-500	1,100	6,000 - 8,000
Combination	$ 1,300	$ 5,000-6,000	$ 40,000 - 50,000

*Figures are approximate; they are intended only as a general indication of sales.

Source: BIA Personal Communication

Folds are responsible for considerable hydrocarbon accumulation, especially in the Arbuckle, Simpson, and Mississippi lime intervals. Only a few fields in Pennsylvanian strata are completely structurally controlled.

Porosity-permeability traps, other than those related to near-surface weathering associated with the major unconformities, occur in the Arbuckle, possibly in the Mississippi lime, and in some of the Pennsylvanian limestones. Entrapment in these rocks may still be in large part related to superposed folding.

Unconformity traps occur at each of the major unconformities that bound the stratigraphic sequences. Entrapment is in coarse detritus along the erosion surface, commonly on the flanks of topographic highs, and in weathered carbonate rock of the underling unit.

Uranium

Economic concentrations of uranium have not been found within the boundaries of Osage County or any of the counties bordering it in either Oklahoma or Kansas. Several minor radioactive occurrences (Figure 18) have been noted, however, and were investigated (Table 4) by the Atomic Energy Commission and the U.S. Geological Survey. Most such occurrences (USAEC and USGS, 1968, p. 49-56) have been radioactive crude oil and brines from producing oil wells. According to Creath and Upshaw (1977, p. 52), it is not known whether the anomalously high radioactivity investigated in the area is ". . . caused by potassium, uranium, radium, the concentration of daughter products of radioactive decay by ground water, or other reasons."

Under a contract from the Energy Research and Development Administration (ERDA), personnel of Environmental Sciences Corp. of Tulsa examined several hundred gamma-ray logs of oil wells in northeastern Oklahoma for anomalous radioactivity. The examination resulted in a recommendation (Table 5) to drill several exploratory holes on the Osage Reservation (Creath and Upshaw, 1977, p. 66-82).

TABLE 4

Radioactive Occurrences in Osage County That Were Investigated by Aec and Usgs

Section	Location Township	Range	Type of occurrence
1	21 N	7 E	Brine from Boston oil pool
7	21 N	9 E	Oil well brine
9	20 N	12 E	Salts precipated around outlet pipe from oil storage tanks
24,25	24 N	11 E	Sand and gravel deposit
S ½ 32, SW ¼ 33	22 N	8 E	Arkansas River floodplain*
E ½ 11, W ½ 12	24 N	11 E	Sandstone outcrop and producing oil well

*May be inundated by waters of Keystone Lake

Source: AEC Radioactive Mineral Evaluation 151

TABLE 5

Proposed Drilling to Test Anomalous Radioactivity as Shown by an Investigation of Gamma-ray Logs

Section	Location Township	Range	Formation or zone	Depth (ft)
NESESE 12	28 N	8 E	Lower Layton Sand Zone	1,550
SE ¼ 7	24 N	8 E	Labette Zone	2,100
			Prue Zone	2,240
SW ¼ 24	24 N	8 E	Cleveland Sand	1,500
NW ¼ 25	24 N	8 E	Cottage Grove-	1,320
			Cleveland-	1,630
9	23 N	8 E	Layton Zone-	1,610
			Cleveland Zones	1,640
NENENW 27	24 N	12 E	Marmaton-	1,200
			Pru Zone	1,500
SW ¼ 1	21 N	7 E	Layton-	1,050
			Red-Fork-Bartlesville	2,130
NW ¼ 14	21 N	8 E	Layton Sands-	1,150
			Cleveland Zones	1,630
SW ¼ 17	23 N	12 E	Pru Zone	1,000

Source: Creath and Upshaw, 1977, Feasibility Study for Potential Drilling and Logging Sites in Northeastern Oklahoma: Environmental Sciences Corp., Tulsa, Okla, 134 p.

The grade and extent of uranium resources on Osage land are unknown. Indeed, it is not understood whether the known radioactive anomalies result from the decay of uranium, radium, or an isotope of potassium. Whether uranium actually exists and whether it exists in economic concentrations necessarily will have to await exploration of the radioactive anomalies.

The Osage Reservation is within the geographic bounds of the Enid 2° quadrangle and is presently being examined as part of the NURE program of the Department of Energy designed to detect and evaluate uranium occurrences. Presently the Enid 2° study is in Phase I status, a literature search and geologic map compilation. Final fieldwork and reports are due to be completed in 1980 (K. S. Johnson, personal comm., 1978).

Nonmetallic Mineral Resources

Nonmetallic mineral resources within the reservation include limestone, dolomite, sandstone, clay, and sand and gravel. All of these commodities have been produced in the past, but currently only limestone is produced on a sustained basis. Sandstone, in the form of flagstone, is produced occasionally in minor quantities, and dolomite is produced from an old quarry for concrete aggregate (Figure 19).

Limestone

Limestone, at least in minor quantities, may have been produced from the area before the reservation was formed in 1872. Bureau of Indian Affairs records indicate that the tribe did not begin receiving revenues from stone production until 1942, but much material was quarried before that date. Bellis and Rowland (1976, p. 32) describe a quarry in the Avant Limestone in sec. 17, T. 23 N., R. 12 W., which was operated during the 1920's by the Midland Valley Railroad. It produced about 1.3 million tons of stone for use as railroad ballast.

Currently, two companies produce crushed limestone from four quarries on the reservation (Figure 19). Table 6 lists stone quarries on the reservation, shows whether they are active or inactive, and, where known, gives the thickness and name of the geologic unit quarried. Table 7 shows limestone production for the past 10 years from quarries on the reservation.

All limestone currently produced on the reservation is used as crushed stone. Bellis and Rowland (1976, p. 29) show the Deer Creek-Lecompton limestone to have a $CaC0_3$ content of 95.02 percent. Most authorities maintain that a limestone with a $CaC0_3$ content of 95 percent can be used for chemical and metallurgical purposes. In actual practice, however, nearly all limestone used for chemical and metallurgical purposes in the United States has a 97 percent or greater $CaC0_3$ content (Hibpshman 1971, p. 4). Limestone of 97 percent $CaC0_3$ content may occur on the reservation, but published analyses do not show that such material exists.

Vast quantities of limestone suitable for crushed stone and perhaps other uses are available within the reservation boundaries.

TABLE 7

Limestone Produced on the Osage Reservation, 1967-1977

Year	Quantity (cu yds)*	Tribal Revenues
1967	232,118	$23,212.00
1968	317,022	31,702
1969	320,770	32,452
1970	327,449	32,823
1971	224,123	22,412
1972	372,834	43,285
1973	684,749	90,891
1974	244,062	26,767
1975	401,052	55,390
1976	352,016	54,347
1977	329,074	46,436

*Some limestone is sold by the ton and some by the cu yd. All stone sold by the ton was converted to cu yds by using 2,570 lbs per cu yd.

Source: BIA Records

Dolomite

Dolomite (high-magnesium carbonate rock) occurs on the reservation and has been quarried from the Wildhorse Dolomite Member at two locations in sec. 19, T. 22 N., R. l0 E. Both quarries ceased operating about 1964. According to Bellis and Rowland (1976, p. 44), about 7 million tons of stone was removed from the quarry in NE ¼ sec. 19 to construct State Highway 20 and Keystone Dam. The quantity of stone removed from the other site is unknown. In May 1978, however, the southernmost quarry was reopened by Park Concrete of Tulsa to obtain crushed stone for concrete aggregate (Figure 19).

Although all dolomite produced from the reservation thus far has been used for concrete aggregate or road metal (stone), it is evidently of high enough quality to be suitable for calcining to dead-burned dolomite. Dead-burned dolomite has a variety of industrial applications, such as the manufacture of rubber, rayon, insulation, and fluxes.

Source: BIA Records (Comstock, 1963, p. 4). Bellis and Rowland (1976, p. 29) show an analysis of a sample from the quarry in NE ¼ sec. 19, T. 22 N., R. 10 E., having a magnesium oxide (MgO) content of 18.67 percent. Although this is a high enough MgO content for some industrial applications, the production of magnesium metal from dolomite requires an MgO content of 20 percent or greater.

Minable dolomite resources in the Wildhorse Dolomite Member on the reservation are contained in a bed averaging about 20 ft in thickness underlying one township (T. 22 N., R. 10 E.). The resource, constituting hundreds of millions of tons, is sufficient to supply any conceivable need.

Sandstone

Sandstone has been produced from the reservation both for use as crushed stone and as flagstone. Some also may have been quarried for use as dimension stone.

Most sandstone production has been from the southern part of the county, but a small quarry that yields flagstone is east of Pawhuska (Figure 19). The geologic unit that probably has yielded most of the sandstone produced on the reservation is the Wann Formation. The Wann Formation contains two units: (1) The Torpedo Sandstone, and (2) The Clem Sandstone. It is not known which was the major producing unit. No sandstone is produced currently on a commercial basis, but flagstone is produced in minor quantities by individuals for personal use. Table 8 shows sandstone production from deposits on the reservation between 1967 and 1977.

Sandstone quarries on the reservation tend to be small (one to three acres), and they operate only for short periods of time. Sandstone production in the future probably will follow about the same pattern as in the past. If any large dams or other major construction projects were installed nearby, large quantities of sandstone could be quarried for aggregate and riprap. It is more likely, however, that limestone from operating quarries would be used for such purposes.

Sandstone resources on the reservation are sufficient to supply stone indefinitely. No information is available concerning the quality of the material on the Osage land. Therefore, it is not known whether any sandstone on the reservation would meet specifications for high-silica material.

TABLE 8
Sandstone Produced on the Osage Reservation, 1967-1977

Year	Quantity (tons)*	Tribal revenues**
1967	867	$ 86.69
1968	10	1.00
1969	520	46.00
1970	282	28.21
1971	0	0
1972	0	0
1973	65	7.80
1974	693	83.16
1975	635	85.35
1976	279	197.16
1977	272	522.00

*Some sandstone was sold by the cu yd. It was converted to tons by using 2,-550 lbs per cu yd.
**Sandstone is sold for use both as crushed stone and as flagstone, which may account for some of the variation in revenues from year to year.
Source: BIA Records

Clay and Shale

Clay and shale occurrences are numerous in Osage County, but production has been recorded from only two locations. One is the old Pawhuska Vitrified Brick Co. pit and plant in NE ¼ sec. 5, T. 25 N., R. 9 E. (Figure 19) and the other is described by Carl (1957, p. 71) as being in sec. 21, T. 20 N., R. 10 E., an area that may now be inundated by waters of Keystone Lake.

The clays and shales of the area were sampled and tested by Bellis and Rowland (1976, p. 4-24). They found many of the resources in the county suitable for the manufacture of various types of brick, tile, and sewer pipe. At least two formations (the Coffeyville Formation and the overlying Hogshooter Limestone) currently are being mined from areas outside the reservation and used to make pottery and bricks, and according to Bellis and Rowland, material from these formations would be suitable for the manufacture of all types of structural clay products as well as artware. Another deposit is in the Vamoosa Formation, which contains the Kanwaka Shale. This unit yielded clay for the manufacture of bricks at the old Pawhuska Vitrified Brick Co., which closed down in the early l900's. Rocks units that have potential for clay and shale products are listed in Table 9.

Clay and shale resources on the reservation probably are sufficient to last indefinitely, but the economic feasibility of mining some of the clay and shale is unknown. Furthermore, it is not known whether shale resources on the reservation are suitable for the production of expanded shale products for use as lightweight aggregate.

Sand and Gravel

Major deposits of sand and gravel on Osage land are limited to the Osage County side of the Arkansas River and its flood plain. Other small deposits are found along various streams in Osage County. Deposits in the Arkansas River are renewable, and the small deposits along the lesser streams probably are sufficient to supply local markets. Figure 19 shows known sand and gravel pits on the reservation. The pit in T. 26 N. R. 3 E., apparently operates on an intermittent basis. Table 10 shows sand and gravel production from deposits on the reservation between 1967 and 1977.

TABLE 9

Rock Units That Have Potential for the Manufacture of Clay Products*

Rock Unit	Possible Uses
Coffeyville Formation - Hogshooter Limestone	All structural clay products, artware**
Nellie Bly Formation and Dewey Limestone	Common and facing brick and possibly sewer pipe
Chanute and Wann Formations	Common and facing brick
Barnsdall Formation	Common and facing brick, possibly sewer pipe
Tallant and Middle Vamoosa Formations	Sewer pipe, common brick, facing brick, and decorative brick
Upper Vamoosa Formation	Sewer pipe, common brick, facing brick, possible use in the sintering process**
Bird Creek Limestone Member thru the Auburn Shale	Possibly common and facing brick
Reading Limestone thru Brownville Limestone	Sewer pipe, common and facing brick decorative brick
Beattie Limestone thru Herington Limestone	Sewer pipe, common and facing brick

*Bellis and Rowland, 1977, Shale and Carbonate Rock Resources of Osage County, Oklahoma.

**Has been used successfully from deposits off the reservation.

TABLE 10

Sand and Gravel Produced on the Osage Reservation, 1967-1977

Year	Quantity (tons)*	Tribal Revenues**
1967	1,660	$ 166.00
1968	0	0
1969	0	0
1970	0	0
1971	9,266	644.89
1972	6,259	324.56
1973	2,224	126.59
1974	7,705	924.63
1975	16,816	2,085.58
1976	112,432	9,366.56
1977	20,542	2,462.55

*Sand and gravel is sold both by the ton and by the cubic yard. Cubic yards were converted to tons by using 2,700 lbs per cu yd.

**Variations in royalties probably are attributable to separate negotiations between producers and the tribe.

Source: BIA records

RECOMMENDATIONS FOR FUTURE WORK

The tribe and BIA personnel at the Osage Agency expressed an interest in having their current series of subsurface structure maps revised and updated.

Future exploration for hydrocarbons can be aided by studies directed toward looking for a variety of traps, mainly proven traps such as Pennsylvanian shoestring sands and pre- Pennsylvanian structures. Most discoveries of small shoestring sands have been the result of drilling on structures and little drilling has been directed towards the intervening lows. It is highly unlikely that major sands remain to be found, but many small sands are probably still untested. The area that might be explored first is in the northern part of the reservation where the least amount of drilling has taken place. A sand-shale facies study of the Pennsylvanian in the north could be of benefit.

Pre-Pennsylvanian structural traps hold good potential. These structures are small but can be very productive. Seismic surveys combined with-structure contour maps on the basement, Oswego lime, and Mississippi lime should be effective in delineating new structures to test. A structural contour map on the Precambrian basement would be helpful. The Arbuckle and Simpson in the southern part of the reservation probably are the best targets. (Reeder, 1974).

Carbonate trap potential, especially in the Mississippi lime (Clinton, 1957 and 1959), needs to be examined again. Earlier attempts in the mid 1950's encountered fracture problems. New techniques may make possible economic development of limestones and dolomites that have high porosity and high oil-in-place factors but very low permeability.

The present set of structure contour maps on the Oswego lime and Mississippi lime should be updated where new data are sufficient to warrant the effort. This might reflect small, but significant structure anomalies not outlined by the 1968 maps. As more and more drilling is done, the potential target areas become smaller and more difficult to define and every bit of data needs to be utilized.

The following is a list of proposed studies concerning non-metallic minerals that may be of value to the tribe in the future:

1. Sample and determine if the Deer Creek-Lecompton Limestones have a $CaC0_3$ content of 97 percent anywhere on the reservation.
2. Determine whether a market exists or could be developed for calcium or calcium products and dead-burned dolomite.
3. Sample and determine whether sandstone on the reservation could meet specifications for high-silica stone.
4. Determine the quality and the mining feasibility of clays in the Coffeyville Formation and Hogshooter Limestone.
5. Determine whether a market exists or could be developed for locally-produced clay.

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TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]

Name	Location		
	Township	Range	Section
Alko	23 N	9 E	17
Almeda	26 N	11 E	13,24,25
Apperson, SW	26 N	5 E	18
Atlantic	25 N	7 E	24,25
(Atlantic, E;	25 N	8 E	1-3,9-12,14-17,19-24 26-31,33-34
Myers, S; New England;	25 N	9 E	6,19,20,29,30
Pawhuska Dist., W)	26 N	9 E	30,31
Atlantic, N	25 N	8 E	8
Avant	23 N	11 E	1,2,11-15,23-26,35
	23 N	12 E	5-9,17-20,30
	24 N	11 E	13,14,23-26,35,36
	24 B	12 E	7,18-21,28,32
Avant, W	22 N	11 E	4-6,8,9,16,17
	23 N	10 E	14,23-27,34-36
	23 N	11 E	15,16,19-22,27-34
Band Wheel	23 N	8 E	1,12-14
(Manion, N)	23 N	9 E	3-9
	24 N	9 E	29,31-33
Barker	23 N	7 E	1,2,11-14
(Dalton, S;	23 N	8 E	6,18,19
Kasishke; Kasishke, S;	24 N	7 E	13,24,25,35,36
Oliphant)	24 N	8 E	18-20,29,30
Barnsdall	24 N	10 E	12,13
(Bigheart)	24 N	11 E	1-12,14-22,27-34
Barnsdall, S	23 N	10 E	1,12,13
	23 N	11 E	4-9,17,18
	24 N	10 E	25,36
	24 N	11 E	30,31
Barnsdall, W	24 N	10 E	1,2,10-14,23,24,26,27

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]--Continued

Name	Location: Township	Range	Section
Bartlesville-Dewey	25 N	13 E	3-5,8
	26 N	12 E	1-4,9-17,20-27
	26 N	13 E	1-24,26-30,32-35
	26 N	14 E	5-8,17,18
	27 N	12 E	1,2,12-16,21-28,33-36
	27 N	13 E	1-36
	27 N	14 E	4-8,17-20,29-32
	28 N	12 E	24,25,35,36
	28 N	13 E	15,16,19-23,26-36
	28 N	14 E	31
Belford, NW	24 N	4 E	18-20,30
Belmont			
Big Bend . . . . (Big Bend, S)	25 N	3 E	20,21,28,29,32,33
Big Bend, E	25 N	3 E	22
Big Bend, N	25 N	3 E	5-8
Big Bend, W	25 N	2 E	24,25
	25 N	3 E	19
Bighorse, NE	27 N	12 E	8,17-19
Birch Creek	24 N	10 E	21,27,28,33,34
Birch Creek, S	23 N	10 E	4
Birch Creek, W	24 N	10 E	32
Bird Creek	20 N	12 E	1-3,10-12
(Sperry)	20 N	13 E	4-8
	21 N	12 E	1-4,9-17,21-26,34-36
	21 N	13 E	4-9,16-21,28-33
	22 N	12 E	25-27,33-36
	22 N	13 E	31
Blackburn, N	22 N	7 E	5

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]--Continued

Name	Location Township	Location Range	Location Section
Blackburn, NE	22 N	7 E	9
Black Dog	22 N	8 E	14,23
Black Dog, W	22 N	8 E	15
Black Dog Distict, S	22 N	8 E	22,27,29
Blackland	27 N	7 E	1,2,12
Blackland, NE	27 N	8 E	5
Blackland, SW	27 N	7 E	11
Boston, E	22 N	8 E	32
Boston, N	22 N	7 E	25
Boston, W	22 N	7 E	34
Boulanger, NW	29 N	10 E	19
Bowring, E	28 N	11 E	23,26
Branstetter District (Branstetter)	22 N	11 E	22,23,26-29,32,33
Buck Creek	Old name for district in 28 and 29N-9E		
Buell	23 N	9 E	28,29,32
Bulldog	24 N	9 E	17,20,21
Bulldog District, N	24 N	9 E	5-8,16,17
	25 N	9 E	30,31
Burbank	25 N	6 E	1-17,21-24,26-28, 34,35
(Burbank, S; Fairfax;	25 N	7 E	7,18,19
Hickman; Little Chief, NE;	26 N	5 E	1,2,11-13,24
Little Chief, SE; Little Chief, W;	26 N	6 E	2-11,14-23,26-36
Solomon Creek)	26 N	7 E	31
	27 N	5 E	1-5,8-16,21-27,34-36
	27 N	6 E	7,8,17-21,27-34

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]--Continued

Name	Location		
	Township	Range	Section
Burbank, SW	25 N	5 E	3
Burbank Townsite	26 N	5 E	35,36
Caney, NW	29 N	12 E	16
Canyon Creek . . . . (Lone Spring, E)	23 N	10 E	7-9,17-20
Canyon Creek, S	23 N	10 E	32
Canyon Creek, SE	23 N	10 E	21
Cleveland, E	21 N	8 E	9,10,15
Dalton	24 N	7 E	12
	24 N	8 E	5-7
Dalton, NE	25 N	8 E	32
Dalton, W	24 N	7 E	11,12
Dog Creek (Abd.)[2]	28 N	8 E	16
Dog Creek, N	28 N	8 E	9
Dog Creek, NE	28 N	8 E	3
Dog Creek, W	28 N	8 E	17
Doga, E	24 N	5 E	9
Doga, N	24 N	5 E	5,8
Doga, NW	24 N	5 E	7
Doga, SW	24 N	4 E	13
Domes, SW	26 N	10 E	9,10

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]--Continued

Name	Location Township	Range	Section
Domes-Pond Creek	26 N	10 E	1-3,10
(Almeda, NW; Bowring, W;	26 N	11 E	1-6,8-12,14-18, 20-22,27-33
Big Horse Dist.; Domes Dist.;	27 N	10 E	1-17,22-27,33-36
Herd, E; Herd, N;	27 N	11 E	2-11,14-36
Herd, NW; Herd, SW;	27 N	12 E	31
Herd District	28 N	10 E	1-4,8-12,14-16,20-23 25-29,31-34,36
Hickory Creek Dist.; Horn, SW;	28 N	11 E	2,3,5,6,9,10,16,21, 27-31,33,34
Okesa; Okesa, N; Okesa, NE; Okesa, S;	28 N	12 E	5
Okesa, SW; Pond Creek;	29 N	10 E	25-27,29,30,32-36
Pond Creek, SW)	29 N	11 E	14-22,25-32,34-36
	29 N	12 E	31,32
Drum Creek	25 N	4 E	15,16,21,22
Drum Creek, N	25 N	4 E	3-5,8-10
Drum Creek, NW	25 N	4 E	7,15-17,20-22
Drummond Ranch	26 N	8 E	18
Drummond Ranch, N	26 N	8 E	8
Edgewood	21 N	11 E	5,6
Edgewood, S	21 N	11 E	7,8
Elgin, S	29 N	9 E	14-18,20-23,27
Enfisco	26 N	7 E	1,2
	27 N	7 E	35
Enterprise	23 N	7 E	20
Enterprise, N	23 N	7 E	5

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1] --Continued

Name	Location Township	Range	Section
Flat Rock	21 N	12 E	3-10,16-20
(Bird Creek-Flat Rock)	21 N	11 E	25,36
	21 N	12 E	17,19-21,28-33
Flat Rock, W	20 N	11 E	2
	21 N	11 E	35
Flesher	22 N	9 E	1,12
	22 N	10 E	6
Flesher, E	22 N	10 E	5
Foraken, N	28 N	7 E	9
Foraker	28 N	7 E	21,28
Forty-Five	25 N	12 E	3-5,8,9
	26 N	12 E	28,32-35
Frankfort (Abd.)	29 N	6 E	17
Frankfort, S	29 N	6 E	29
Gilliland	22 N	7 E	1
(Gilliland,NW; Gilliland, SE)	23 N	7 E	22,23,25-27,35,36
	23 N	7 E	31
Gilliland, S	22 N	7 E	2
Gilliland, W	23 N	7 E	28
Grainola	Old name of area in Osage County		
Grainola, SW	28 N	6 E	18
Grayhorse, N	24 N	6 E	15
Grayhorse, W	24 N	6 E	16
Grayhorse District	24 N	6 E	14,23
Greenup	22 N	7 E	32,33

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]--Continued

Name	Location		
	Township	Range	Section
Hardy	25 N	3 E	2-4,9,11,12
(Hardy, SE; Hardy, W)			
Hickman	Old name for area now in Burbank.		
Hominy	22 N	8 E	12,13
	22 N	9 E	7,18
Hominy, E	22 N	9 E	15-17,21,22
Hominy, S	22 N	9 E	29
Hominy Falls	21 N	11 E	1,2,11,12
	21 N	12 E	5,6
	22 N	11 E	36
	22 N	12 E	30,31
Hominy Lake, S	22 N	8 E	8,9
Hula, N	29 N	12 E	18
Javine District	22 N	11 E	12,13
(GI Joe)	22 N	12 E	7,17-19
Johnson, W	26 N	10 E	19,30
Kaw	26 N	4 E	1,12-14,23,24
	27 N	4 E	25
(Washunga, E)	27 N	4 E	36
Kaw, S	25 N	4 E	1,2,11,12
	25 N	5 E	5,6,8
	26 N	5 E	31,32
Keystone	19 N	9 E	1,2,25,36
(Keystone, N;	19 N	10 E	2-11,13-23,27,30, 31,33,34
Keystone Dist., SE)	20 N	9 E	11,13-15,21-28,34-36
	20 N	10 E	19,30,33
Keystone District, E	19 N	10 E	1
	20 N	10 E	23,24,27-29,34,36

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]--Continued

Name	Location		
	Township	Range	Section
Keystone District, NE	20 N	9 E	13
	20 N	10 E	4,8,9,18-21
Landon	28 N	9 E	15,16
Landon, N	29 N	9 E	34
Landon, NE	28 N	9 E	12
Landon, NW	28 N	9 E	5-8
Landon, W	28 N	9 E	19
Landon, SW	28 N	9 E	32
Landon District, SE	28 N	9 E	25,36
(Landon, SE)	28 N	10 E	30
Lauderdale	20 N	8 E	1-5,8-14,23,24,26,27
(Cleveland, S; Keystone Dist., . . .	20 N	9 E	7,17-20,29,30,32,33
NW; Lauderdale, S; Mannford	21 N	8 E	10,11,14,15,23-27,
Distr., N; Olney; Southwestern)			34-36
Lone Spring, N	23 N	9 E	1
Lucy Creek	25 N	5 E	20
Lucy Creek, E	25 N	5 E	21
Lucy Creek, N	25 N	5 E	17
Madalene	21 N	10 E	16-18
Madalene, E	21 N	10 E	13,14,22-24
Manion	23 N	8 E	24,25,36
	23 N	8 E	19,20,29,30
Manion, S	22 N	9 E	6
Masham, NW	23 N	4 E	8

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]--Continued

Name	Location		
	Township	Range	Section
McCord, SW	25 N	2 E	11-14
	25 N	3 E	18
McInnis	25 N	8 E	7
McInnis, W	25 N	7 E	10
Mud Creek, S	20 N	10 E	1
Mud Creek, SE	20 N	10 E	2
Myers	26 N	8 E	2,10-12,14,15
Myers, NE	27 N	9 E	31
Naval Reserve	23 N	7 E	3,4
(Naval Reserve, NW;	24 N	6 E	1,2,12
Naval Reserve, W; St. John)	24 N	7 E	4-10,14-23,27,28, 33,34
	25 N	6 E	25,35,36
	25 N	7 E	19,30-33
Naval Reserve, E	24 N	7 E	23
Naval Reserve, S	23 N	7 E	9,10,15-17
Nelagoney	25 N	10 E	12-14,23,24
	25 N	11 E	7,18
Ochelata, N	25 N	12 E	1,2,11,12,14-16,21 23,27,28
Ohio-Osage	21 N	9 E	22,26,27,34
Okesa, E (Abd.)	26 N	11 E	15,16,21
Okesa, W	26 N	10 E	13,14
Osage City District, E	21 N	9 E	1-3,5,8-12,14-17
(Osage City, E)	22 N	9 E	35,36

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]--Continued

Name	Location		
	Township	Range	Section
Osage City District, SE	20 N	9 E	4,5,9
	21 N	9 E	29,31-33
Osage-Hominy District	23 N	8 E	3-5,7-10,15,16
(Falls Dome; Osage-Hominy)	24 N	8 E	28,29,32-34
Page District	19 N	10 E	12,13
(Page)	19 N	11 E	2-10,18
	20 N	11 E	10,11,14,15,20-24, 26-32,35
Pappin	26 N	9 E	3
Pappin, NW	27 N	9 E	20,29
Pappin, W	26 N	9 E	8
Pawhuska	25 N	9 E	2-4,9-11,14,16
Pawhuska, N	26 N	9 E	23
Pawhuska, NE	26 N	9 E	25,36
	26 N	10 E	31
Pawhuska, NW	26 N	9 W	21
Pawhuska, SW	25 N	9 E	17
Paxton, E	22 N	8 E	7
Paxton, SE	22 N	8 E	17
Pearsonia	27 N	7 E	12,13,24
(Pearsons Switch)	27 N	8 E	7,17-20,29
Pearsonia, E	27 N	8 E	21,22
Pearsonia, NE	27 N	9 E	7
Pearsonia, S (Abd.)	27 N	8 E	30
Pearsonia, SE	27 N	8 E	28

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]--Continued

Name	Location		
	Township	Range	Section
Penn Creek	23 N	8 E	27,33,34
Pershing	24 N	9 E	1,3,4,9,10
	24 N	10 E	4-10,15,16,22
	25 N	9 E	23-28,32-36
	25 N	10 E	19,30-32
Pershing, E	25 N	10 E	20,21,28,29,32
Pershing, NE	25 N	10 E	17
Pettit	23 N	8 E	20,21,28,29
Pettit, SE	23 N	8 E	28
Phillips Lake	26 N	6 E	13
Pioneer	20 N	11 E	5,8
	21 N	11 E	32
Pioneer, E	20 N	11 E	3
	21 N	11 E	33
Pioneer, S	20 N	11 E	17
Ponca City, SE	25 N	2 E	1
Pond Creek, NW	29 N	10 E	21
Prairie Springs, SW	29 N	9 E	29-32
Prue	21 N	10 E	25-28,33,34
Quapaw	24 N	11 E	3
	25 N	10 E	25
	25 N	11 E	6,8,9,15-17, 19-22,27-34
Ralston, NE	24 N	6 E	30
Ramona	24 N	12 E	11,14,15,21-23 27,28,33,34

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]--Continued

Name	Location		
	Township	Range	Section
Red Bluff	21 N	11 E	28,29
Red Bluff, NE	21 N	11 E	22
Red Bluff District, N	21 N	11 E	17,20,21
Red Fork District	18 N	11 E	1,2,11-14,23-26,35
(Bowden; Bruner-Vern;	18 N	12 E	4-7,18,19
Red Fork)	19 N	11 E	13,25,36
	19 N	12 E	3-10,14-18,20-24, 26-34
	20 N	12 E	33
Remington	25 N	5 E	1-3,11-13
(Remington, N;	25 N	6 E	8,18
Remington, NW)			
Ritberger, E	26 N	8 E	33
Ritberger, SE	26 N	8 E	32
Ritberger, SW	26 N	8 E	31
Ross Day, E	24 N	4 E	10
Ross Day, N	24 N	4 E	4
Ross Day, NE	25 N	4 E	25
Ross Day, S	24 N	4 E	15
Shell Lake, N	20 N	11 E	7
Shell Lake, NW	20 N	10 E	14,15
Shidler, E	27 N	6 E	26
Signal Hills	23 N	9 E	17,20,21
Skiatook	22 N	12 E	4,5,8-10,12
	23 N	12 E	32,33

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]-Continued

Name	Location		
	Township	Range	Section
St. John, N	25 N	7 E	27
St. John, NW	25 N	7 E	29
Strohm	25 N	7 E	15-17
Strohm, E	25 N	7 E	23
Strohm, N	25 N	7 E	3,4,9
Strohm, NW	26 N	7 E	29
Sundown, SW	22 N	10 E	4,9
Sunset	22 N	9 E	2,3,10
	23 N	9 E	33,34
Sunset, NE	23 N	9 E	26,27
Sunset, W	22 N	9 E	4
Turkey Creek (Turkey Creek, W)	29 N	10 E	13-16,22,24
Watchorn, E	22 N	3 E	2,10,11,15
(Watchorn, S; Watchorn, SE)	23 N	3 E	13,23-27,34-36
Whitetail	26 N	9 E	1,12
(Whitetail, N;	26 N	10 E	6,7,18
Whitetail, S)	27 N	9 E	13,24,25,36
	27 N	10 E	18,19,29-32
Whitetail, NW (Landon, S)	28 N	9 E	21,28
Whitetail, W	27 N	9 E	15
Wildcat Hill	21 N	11 E	30
Wildhorse	21 N	10 E	3-5
	22 N	10 E	10,13-15,22-30, 32,36
	22 N	11 E	7,17-21

Continued

TABLE 2. - Oil- and gasfields in Osage County, Okla.[1]--Continued

Name	Location		
	Township	Range	Section
Wildhorse, N	22 N	10 E	17-20
Wildhorse, NE	22 N	10 E	1,2,11,12
Wildhorse, S	21 N	10 E	2,10,11
Wildhorse, W	22 N	9 E	24,25
Woolaroc	24 N	11 E	1
	25 N	11 E	1,2,11-14,23-26 35-36
	25 N	12 E	30,31
Wynona	24 N	9 E	13-15,21-27,35,36
	24 N	10 E	18,19,30,31
Wynona, S	23 N	10 E	6

[1]Names in this table may not correspond exactly with the names of oilfields on figure 2 because of a continuous process of consolidating fields and districts and occasional abandonment of some fields.

[2]Abd. indicates abandoned.

Source: Blade, O. C. (1969), Johnston, K. H. (1971) and Ferrero, E. P. (1974)

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TABLE 6. - Stone quarries on the Osage Reservation

Location	Commodity	Formation	Thickness (ft)	Status	Operator
NE¼ sec. 19, T.22 N.,R.10 E.	Dolomite	Wildhorse Dolomite	26.0	Inactive	-
CE½ sec. 19, T.22 N.,R.10 E.	...do...	...do.............	26.0	Active	Park Concrete
SE¼NE¼ sec. 3, T.22 N.,R.8 E.	Limestone	Deer Creek - Lecompton Limestone	18.0	Inactive	-
NE¼ sec. 17, T.23 N.,R.12 E.	...do....	Avant Limestone	40.0	...do....	Midland Valley Railroad
SE¼ sec. 7, T.23 N.,R.12 E.	...do....	...do..........	40.0	...do....	-
NW¼ sec. 17, T.23 N.,R.12 E.	...do....	...do..........	40.0	...do....	-
SW¼ sec. 17, T.23 N.,R.12 E.	...do....	...do..........	40.0	...do....	-
SE¼ sec. 8, T.23 N.,R.12 E.	...do....	...do..........	40.0	...do....	-
NE¼ sec. 8, T.27 N.,R.10 E.	...do....	Vamoosa	Unknown	...do....	-
NW¼ sec. 4, T.27 N.,R.10 E.	...do....	...do............	...do..	...do....	-
SE¼ sec. 11, T.27 N.,R.10 E.	...do....	...do............	...do..	...do....	-
NW¼ sec. 12, T.25 N.,R. 8 E.	...do....	Deer Creek - Lecompton Limestone	4.0	Active	Blake Stone Co.
NW¼ sec. 14, T.25 N.,R.8 E.	...do....	...do..............	4.0	Inactive	-
SW¼ sec. 14, T. 25 N.,R.8 E.	...do....	...do..............	4.0	...do....	-
NW¼ sec. 1, T.25 N.,R.11 E.	Sandstone (flagstone)	Barnsdall	Unknown	Active (intermittent)	Private individuals
C sec. 31, T.20 N.,R.11 E.	Sandstone	Nellie Bly	...do..	Inactive	-
SW¼ sec. 24, T.20 N.,R.10 E.	Sandstone	Chanute	...do..	...do....	-
sec. 24, T.22 N.,R. 11 E.	Limestone	Avant Limestone	18.5	Active	Blake Stone Co.
sec. 11, T.25 N.,R.10 E.	...do....	Deer Creek - Lecompton Limestone	Unknown	...do...	Do.
secs. 30 & 31, T.26 N.,R.6 E. sec. 36, T.26 N.,R.5 E.	...do....	Red Eagle Limestone	27	...do...	Standard Industries

Source: BIA Records

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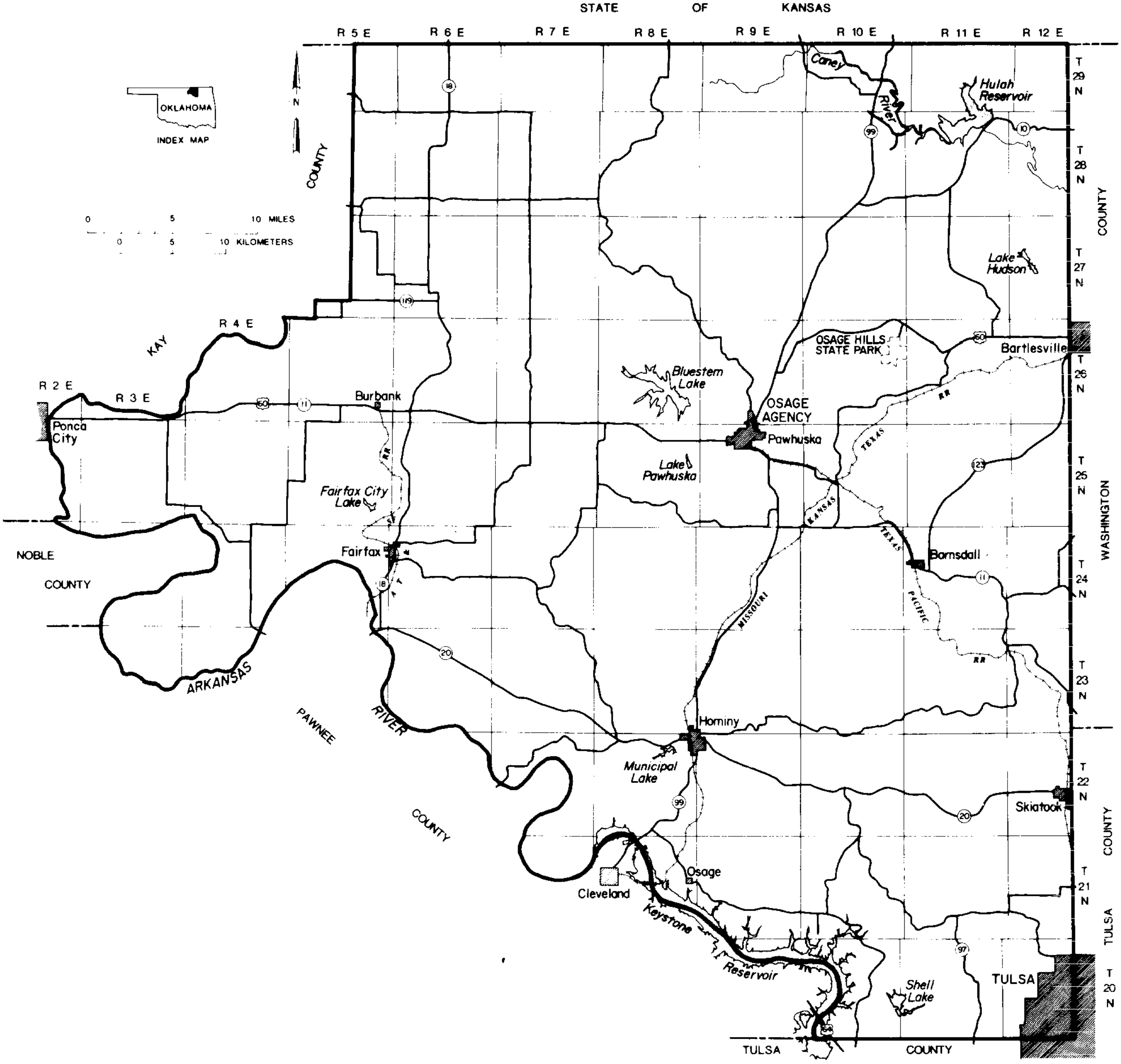

Figure 1. Map of Osage Indian Reservation, Oklahoma.

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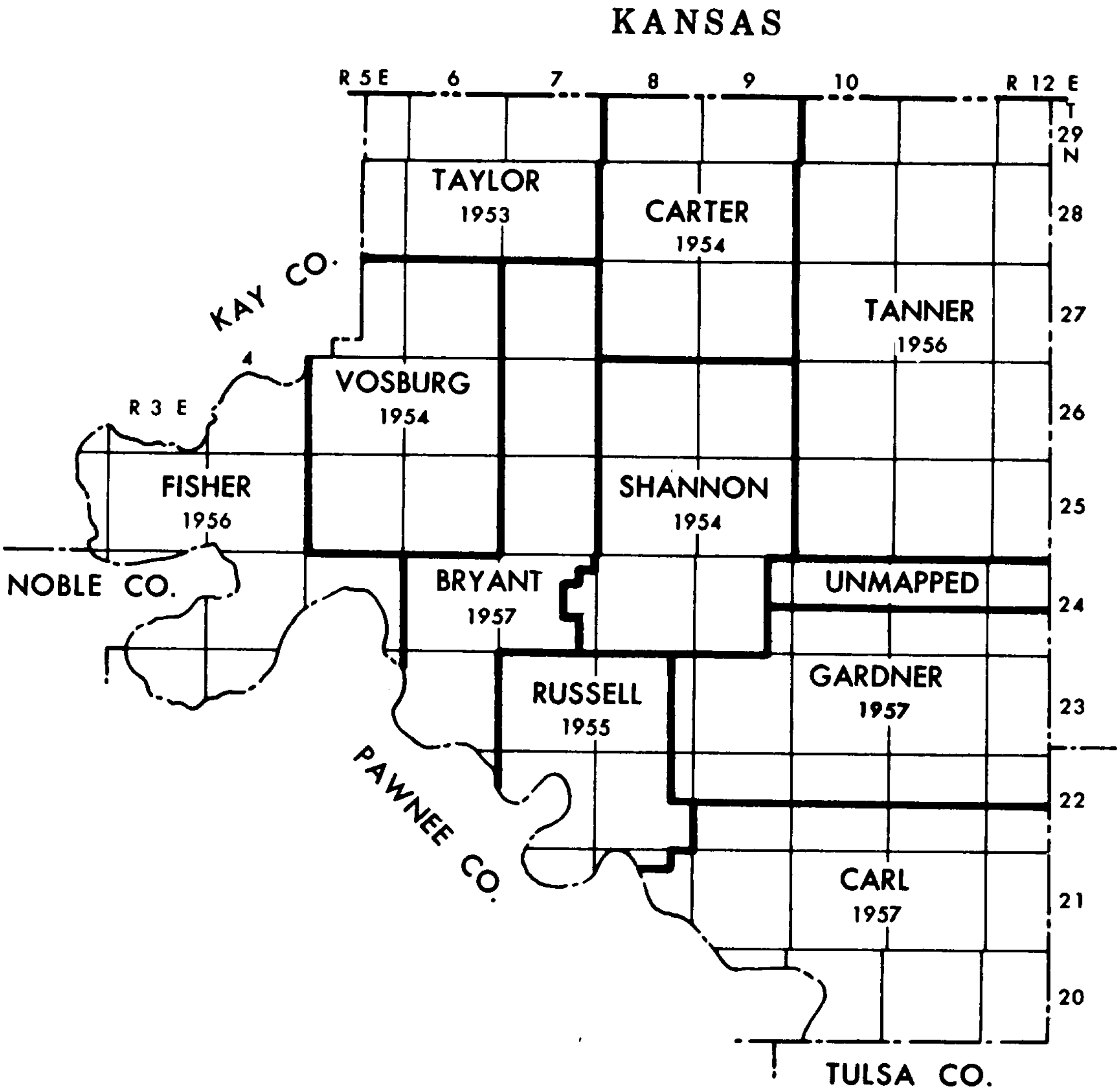

Figure 2. Index to geologic mapping of the Osage Indian Reservation, Oklahoma (from Bellis and Rowland, 1976).

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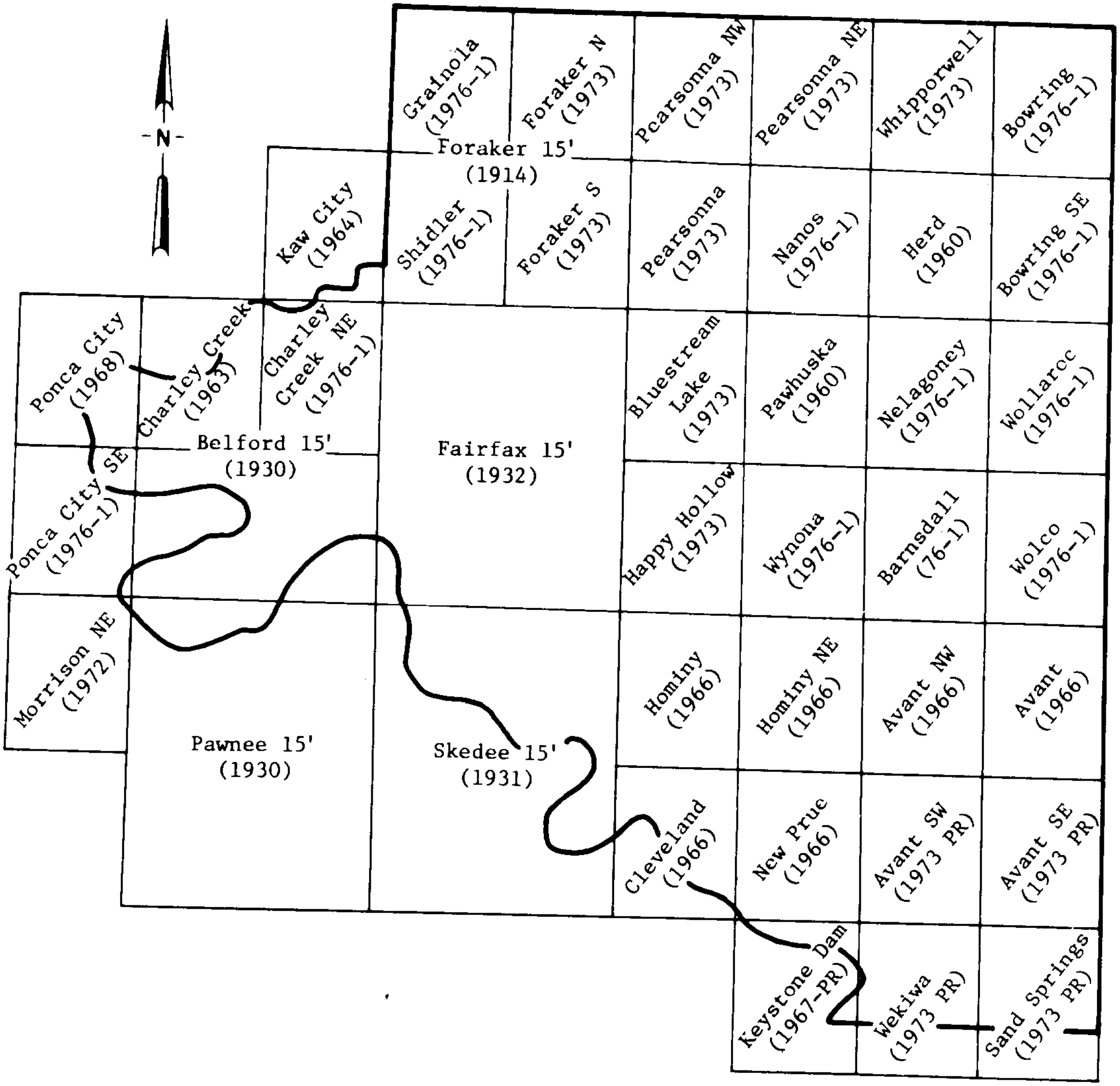

Figure 3. Index map of the Osage Indian Reservation showing available topographic map coverage.

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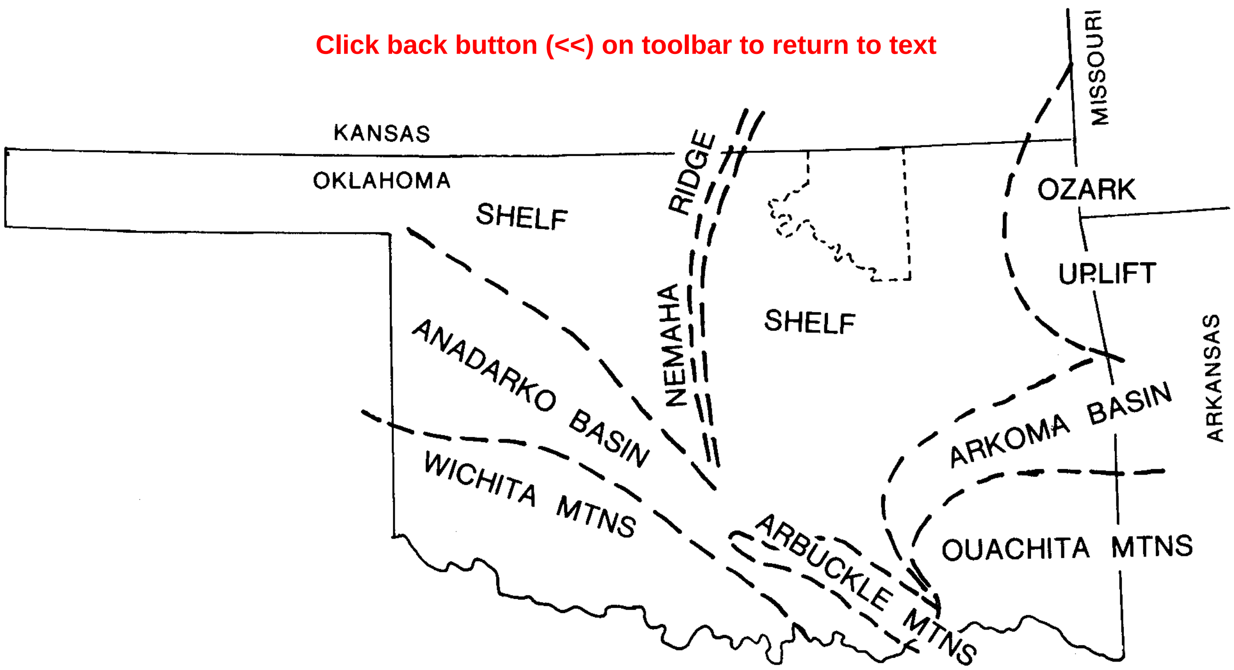

Figure 4. Map of Oklahoma and adjacent states showing major Paleozoic tectonic features and outline of Osage Indian Reservation.

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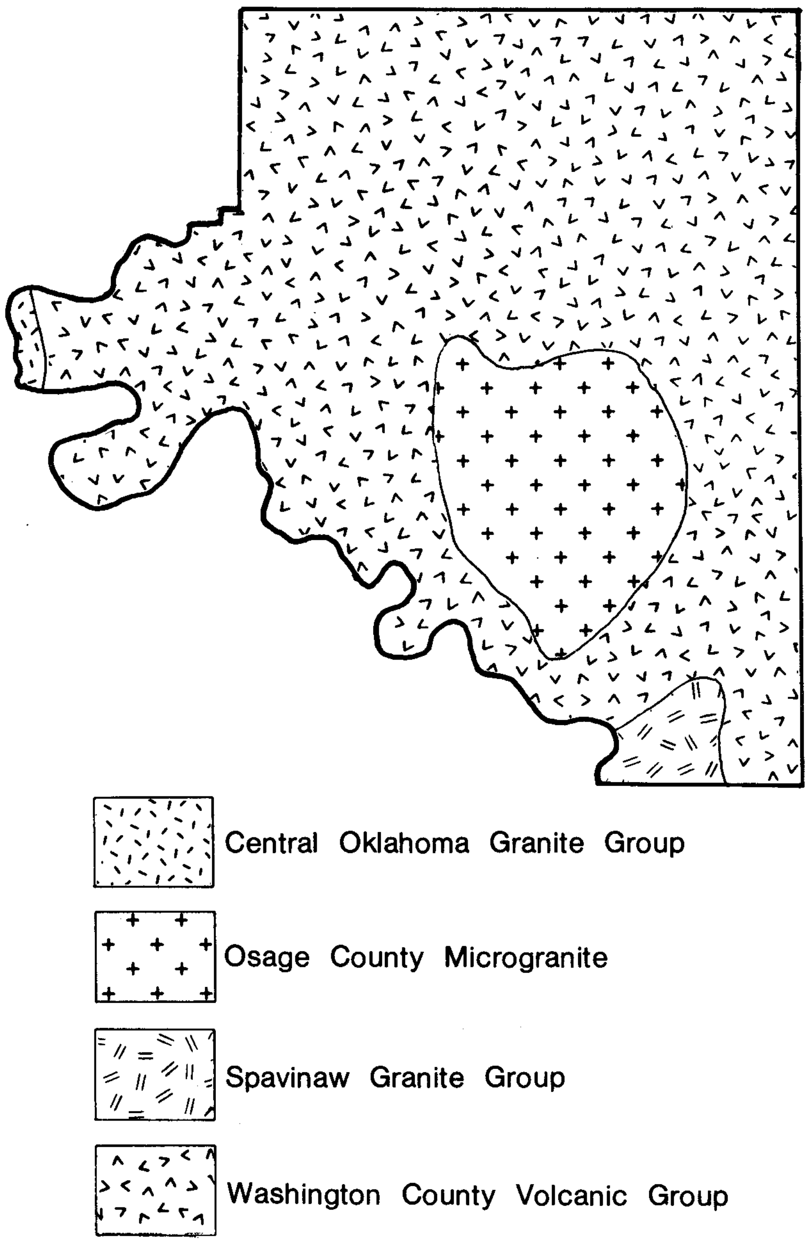

Figure 5. Map showing distribution of Precambrian rocks of Osage Indian Reservation (from Denison, 1966).

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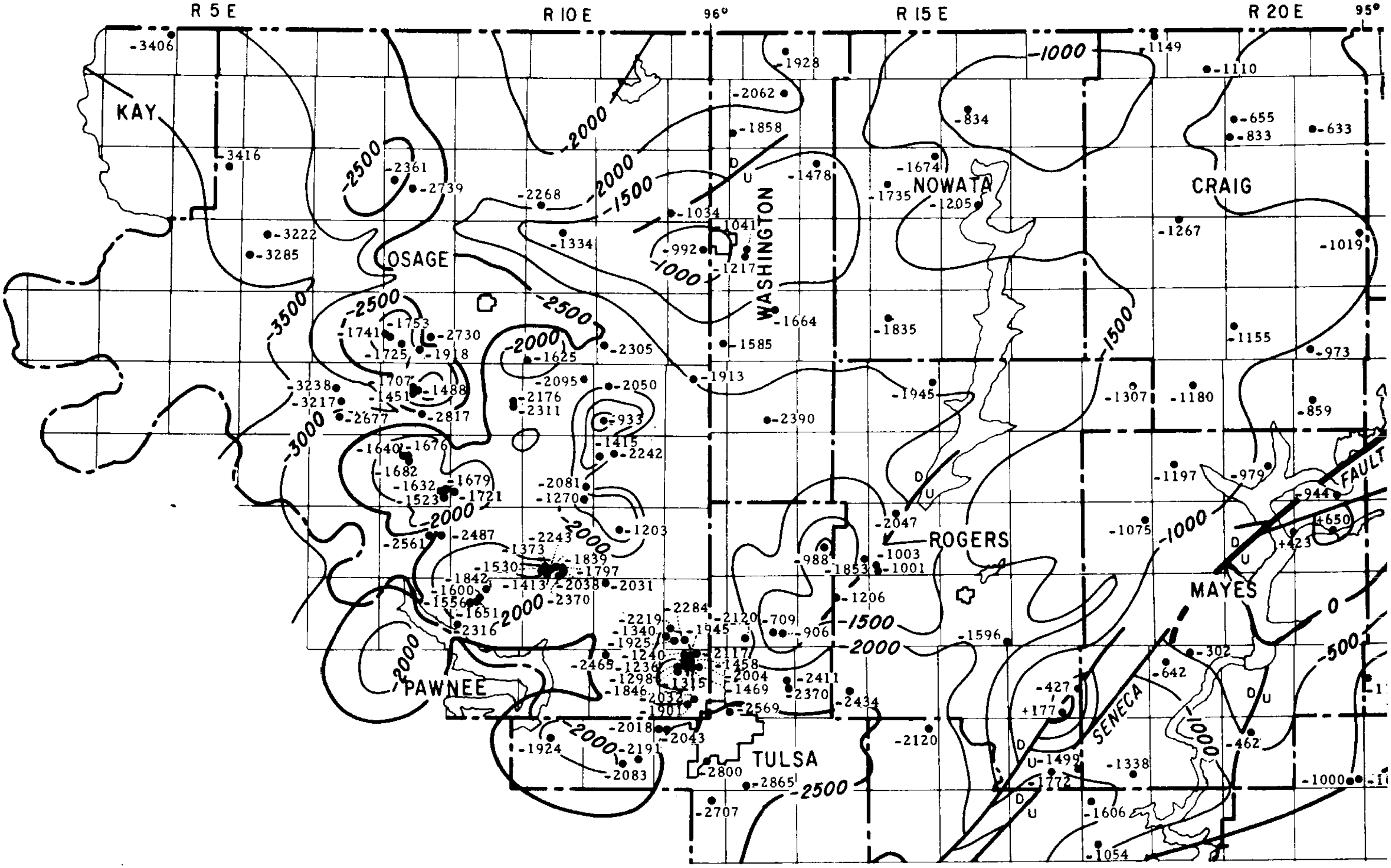

Figure 6. Map showing wells drilled to Precambrian basement and 500 foot contours on basement surface in the Osage Indian Reservation and adjacent counties (from Reeder, 1977).

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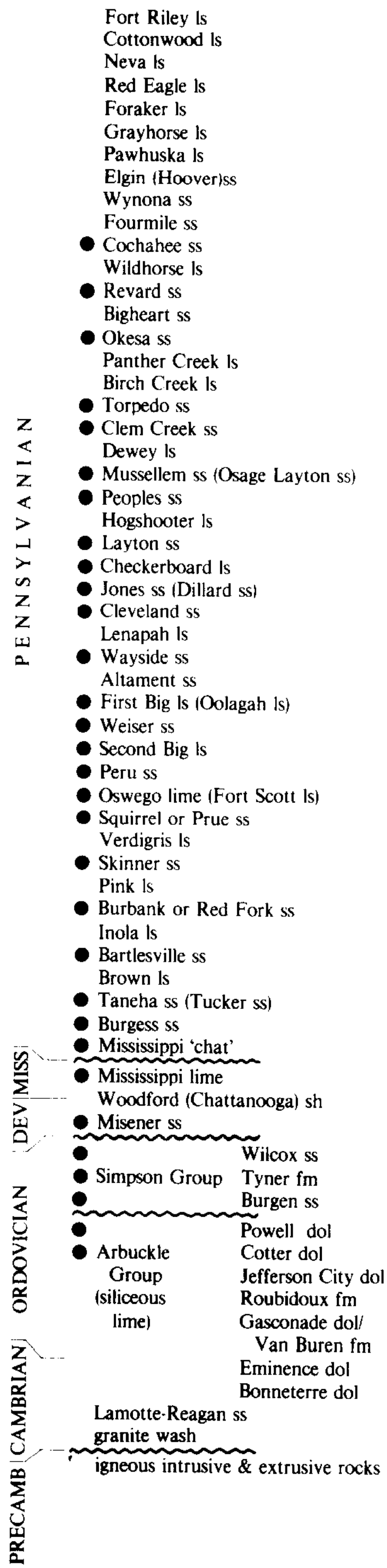

Figure 7. Subsurface stratigraphic column showing common marker beds and formations encountered. Important oil and gas intervals indicated by dot.

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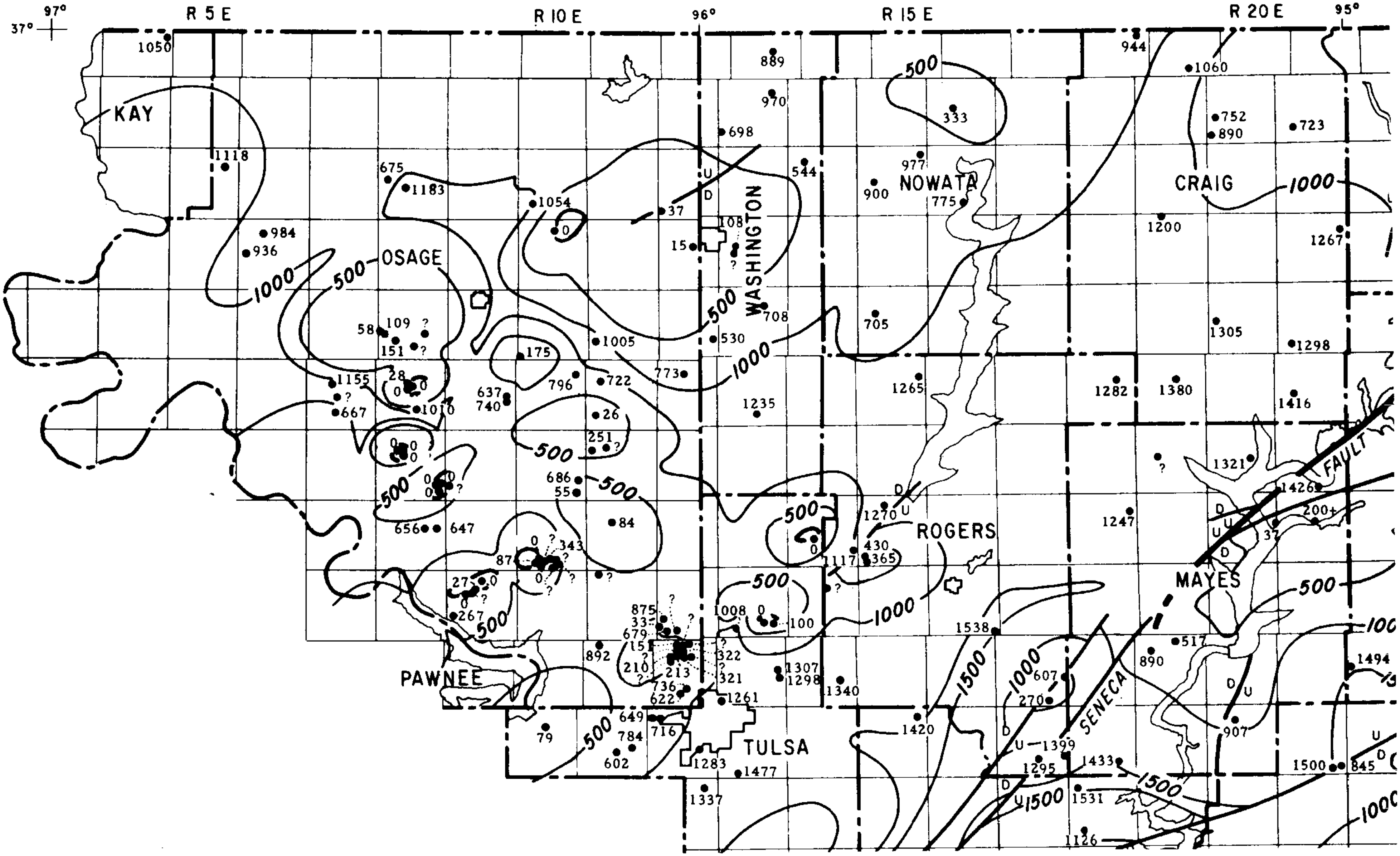

Figure 8. Isopach map of the Arbuckle Group, including the Lamotte-Reagon sandstone in the Osage Indian Reservation and adjacent counties (from Reeder, 1977).

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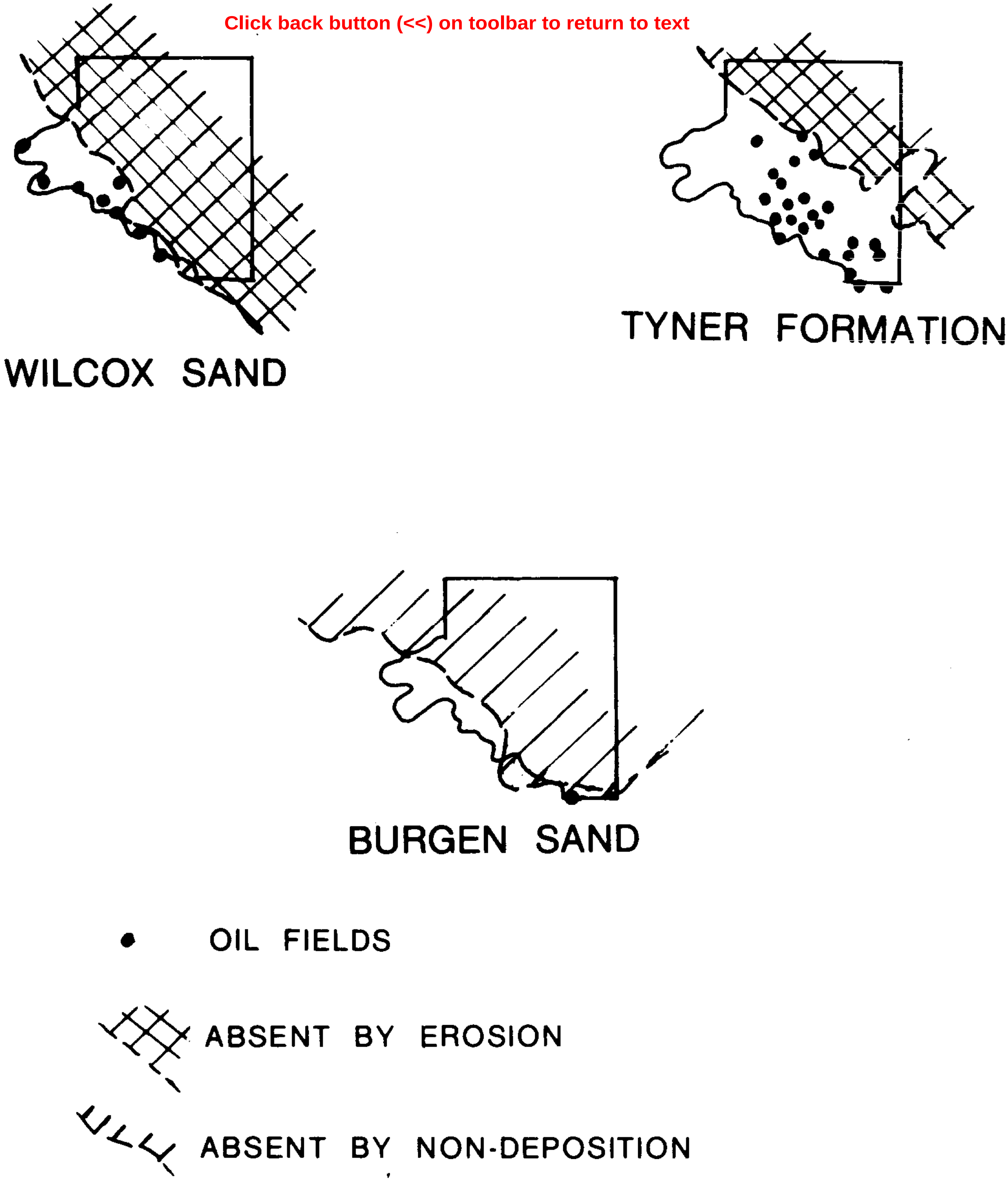

Figure 9. Distribution of Wilcox sand, Tyner Formation, and Burgen sand and oilfields producing from each unit in the Osage Indian Reservation (from Schramm, 1965).

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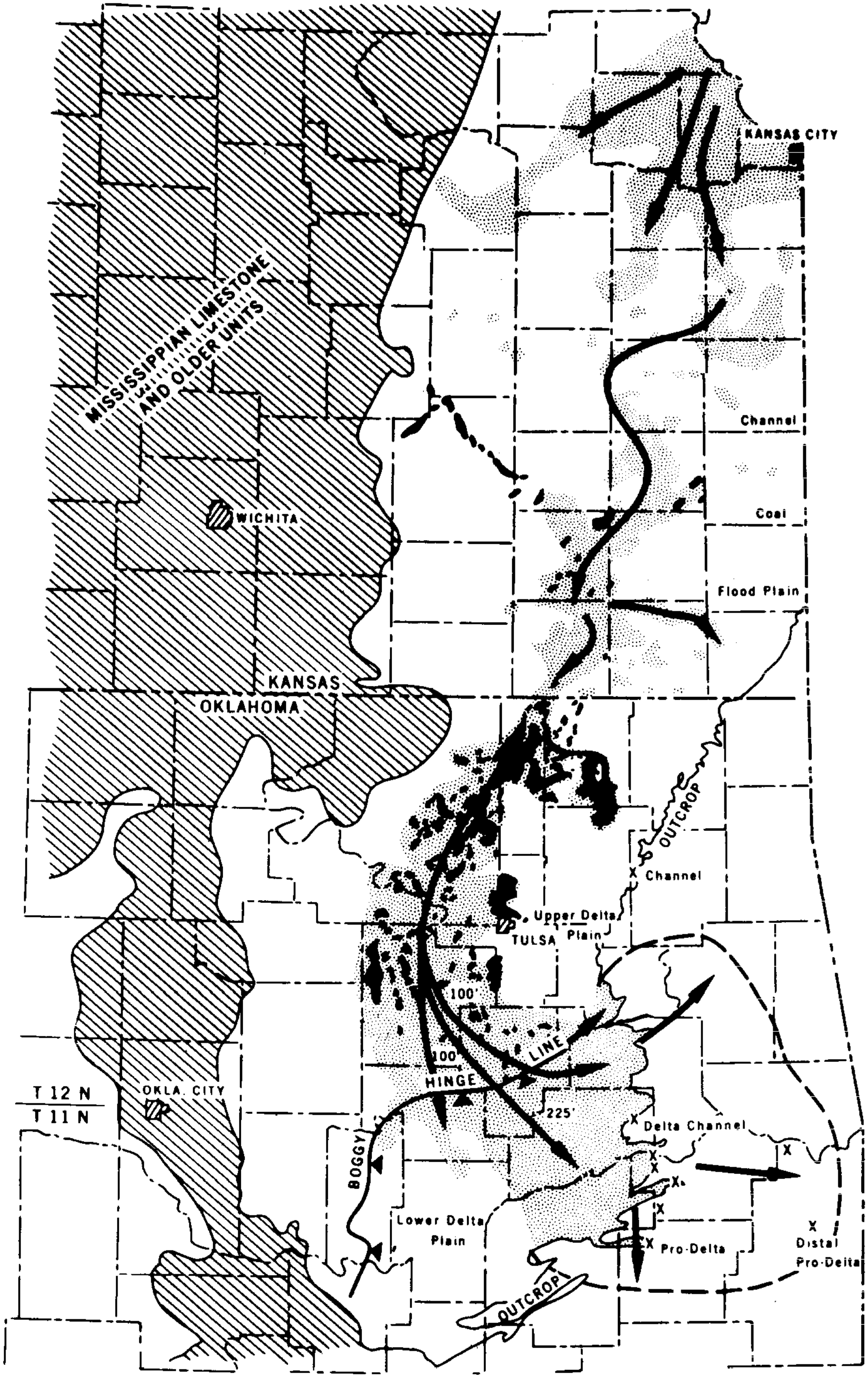

Figure 10. Distribution of Bartlesville sand (black) in northeastern Oklahoma and southeastern Kansas (from Visher, 1968b).

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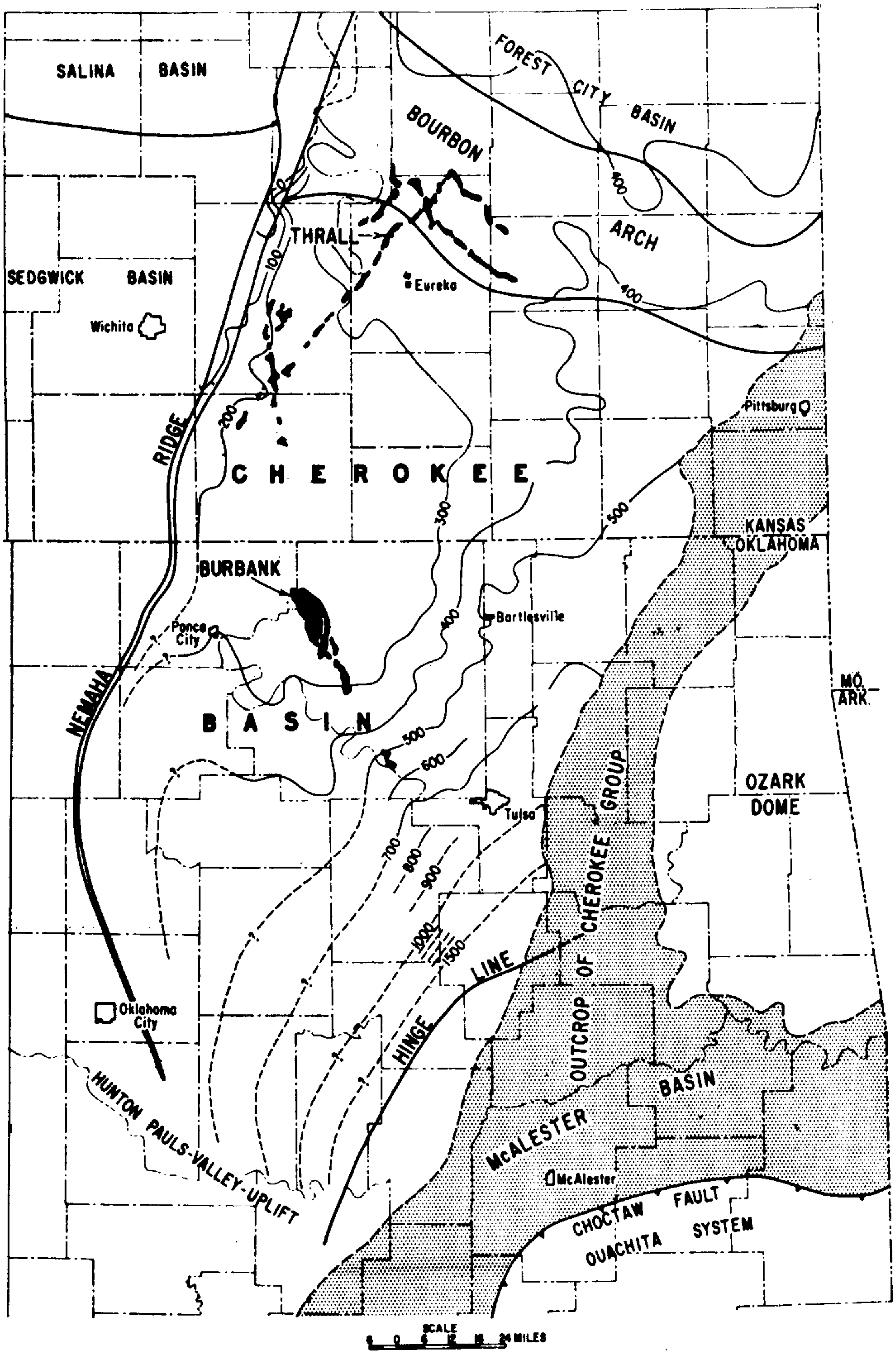

Figure 11. Distribution of the Cherokee age Burbank oilfields in the Osage Indian Reservation and the Thrall oilfields in southeastern Kansas. Isopachs of Cherokee Group (from Baker, 1962).

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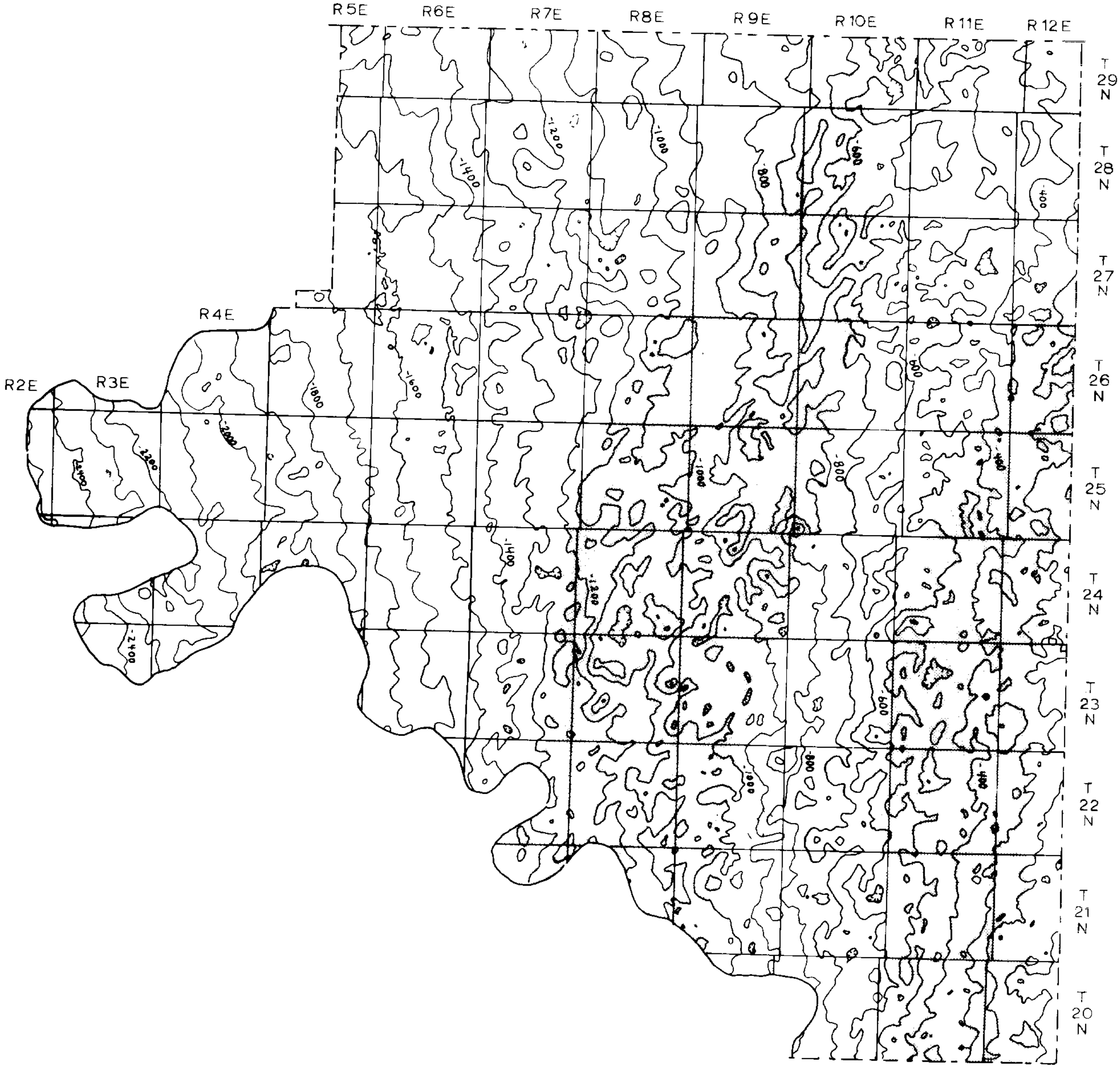

Figure 12. Structure contour map on top of Oswego lime in the Osage Indian Reservation. Contour interval 100 feet. Shaded zones show north-northeast-trending fold belts (from Bass, 1942).

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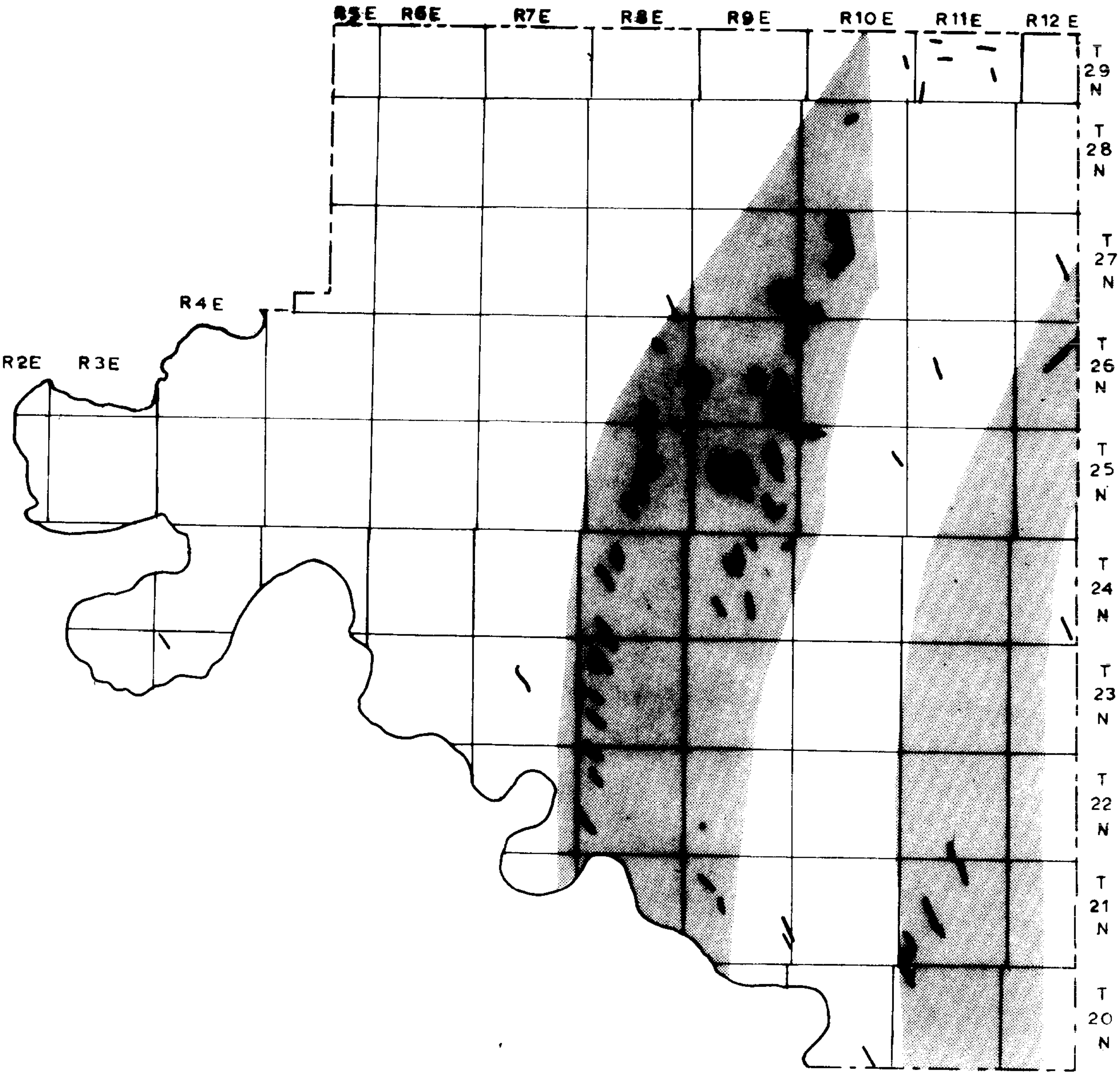

Figure 13. Distribution of en echelon normal faults in Osage Indian Reservation. Shaded areas are fold belts in Osage lime from Figure 12.

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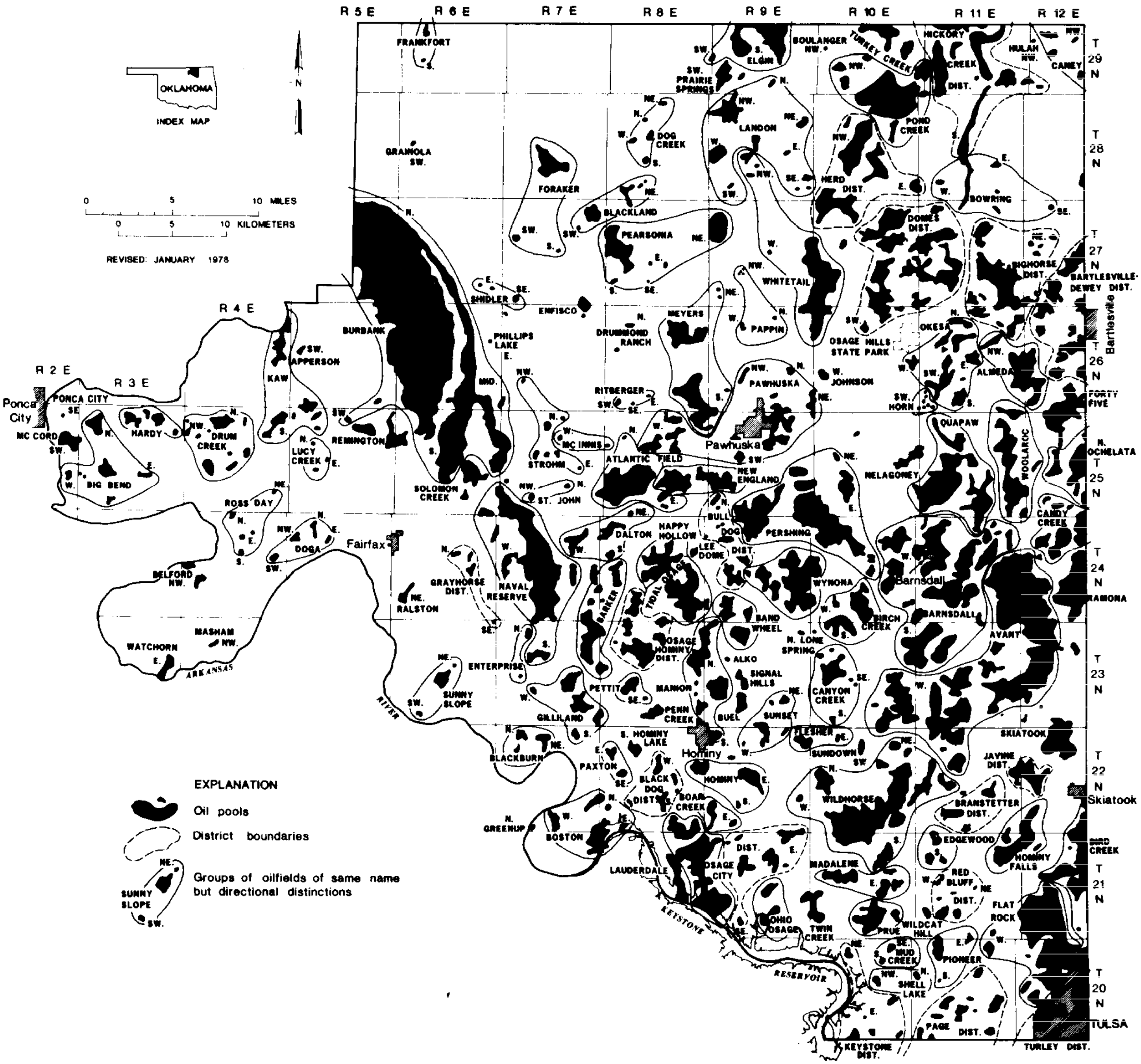

Figure 14. Map showing oil and gasfields on the Osage Indian Reservation.

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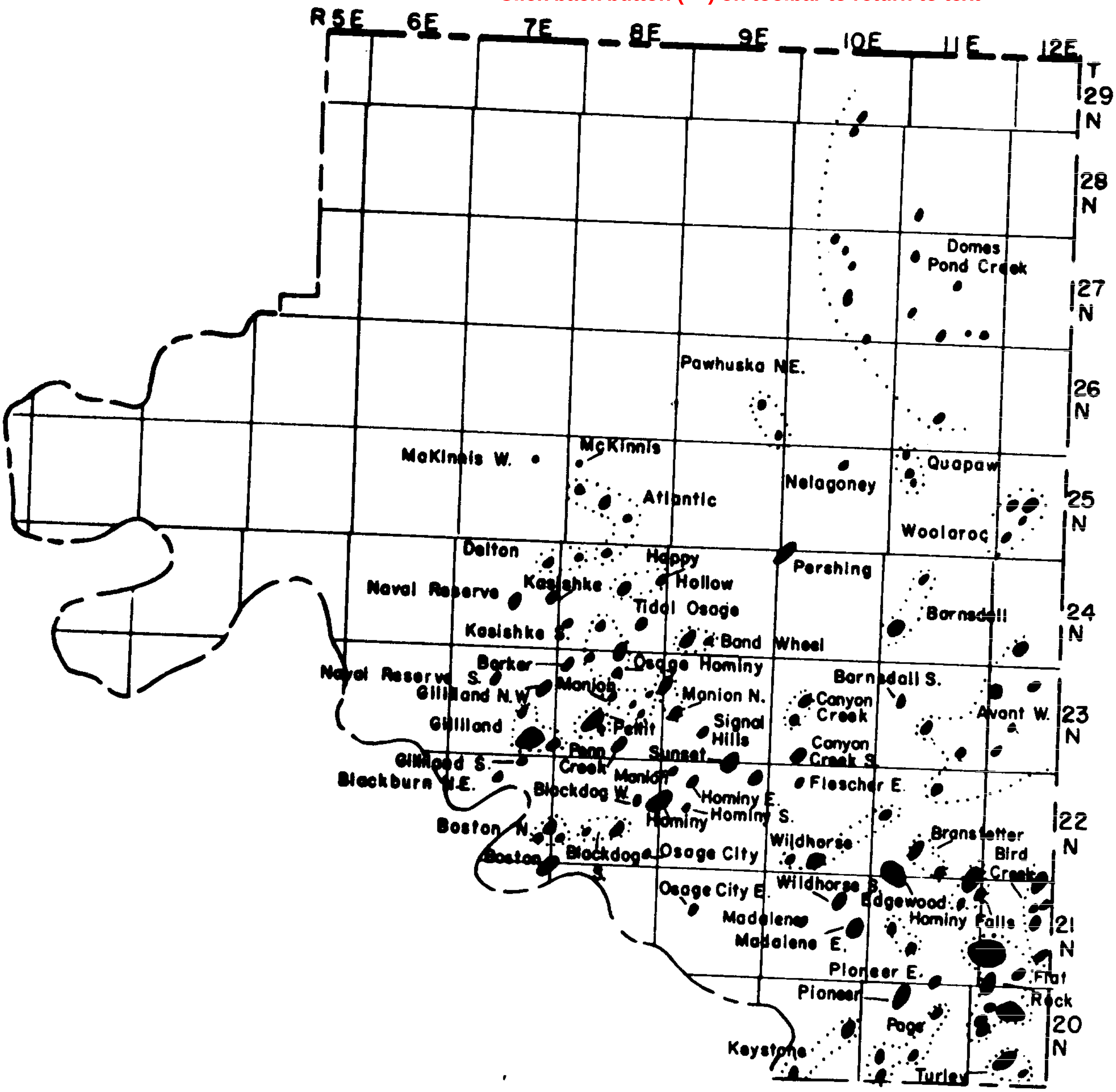

Figure 15. Map showing oil and gasfields in the Arbuckle Group on the Osage Indian Reservation (from Akin, 1964a).

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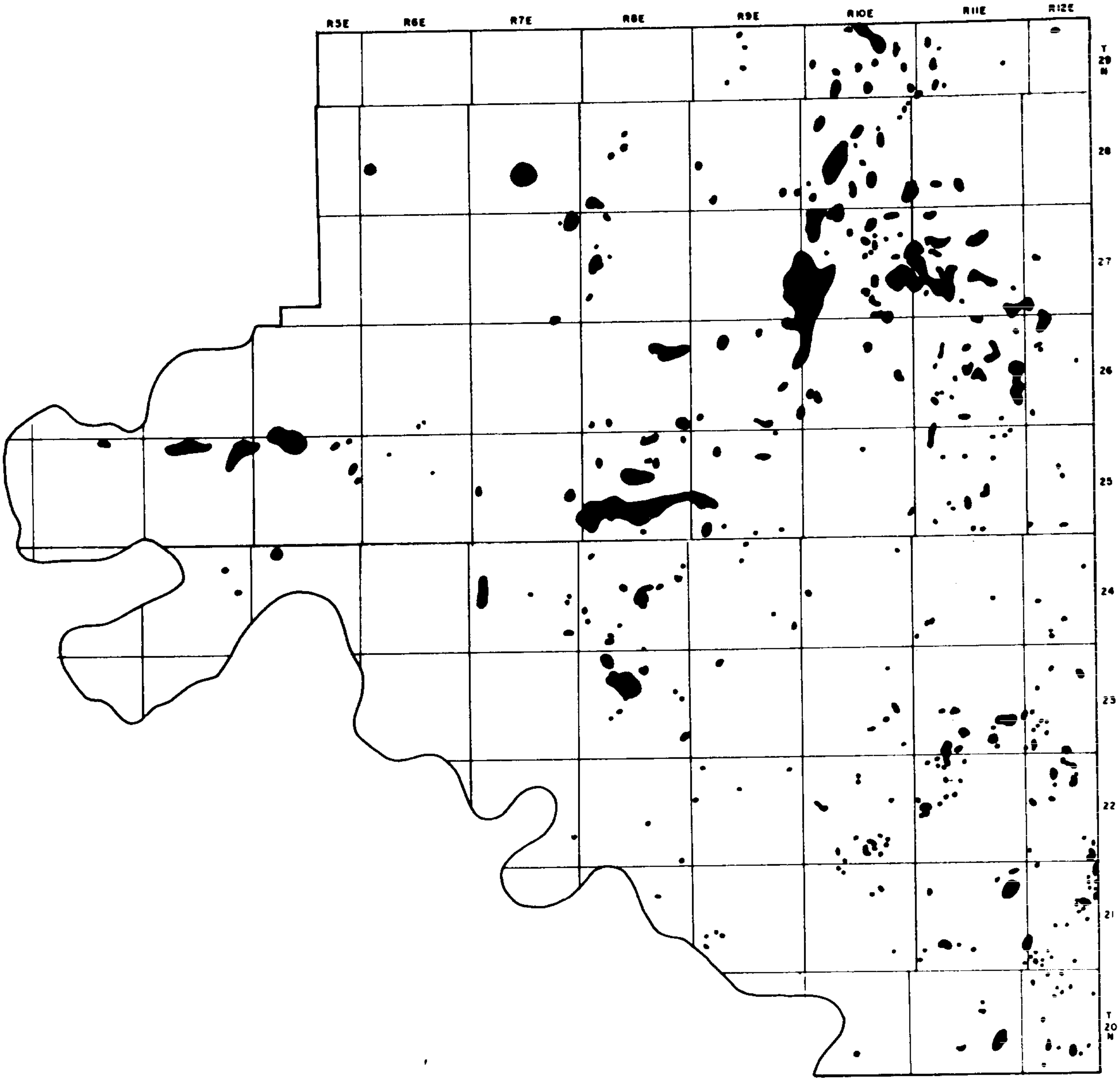

Figure 16. Map showing oil and gasfields in Burgess sandstone - Mississippi lime on the Osage Indian Reservation (from Clinton, 1958).

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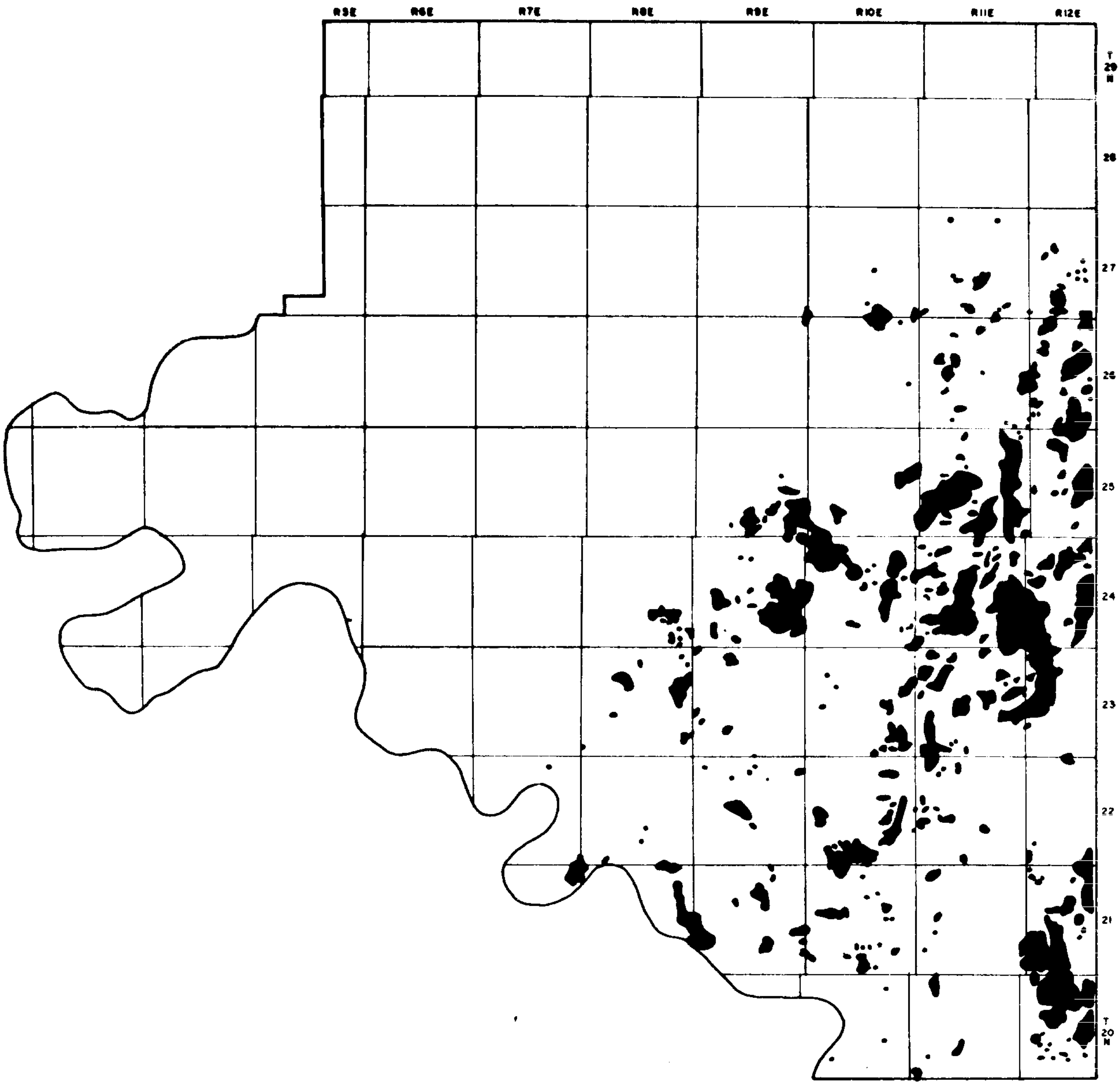

Figure 17. Map showing oilfields in the Bartlesville sand on the Osage Indian Reservation (from Clinton, 1958).

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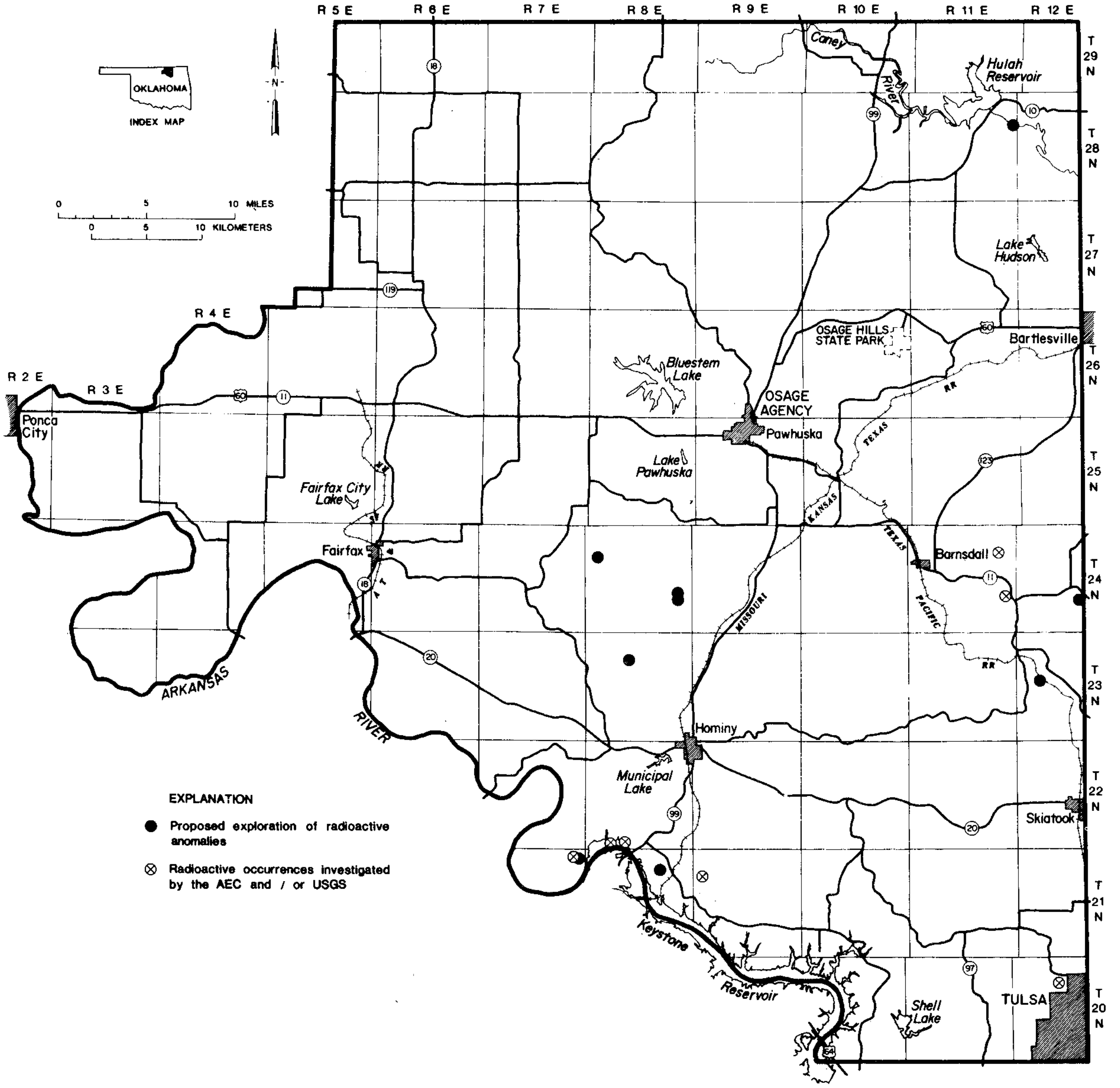

Figure 18. Map of radioactive occurrences and proposed exploration on the Osage Indian Reservation.

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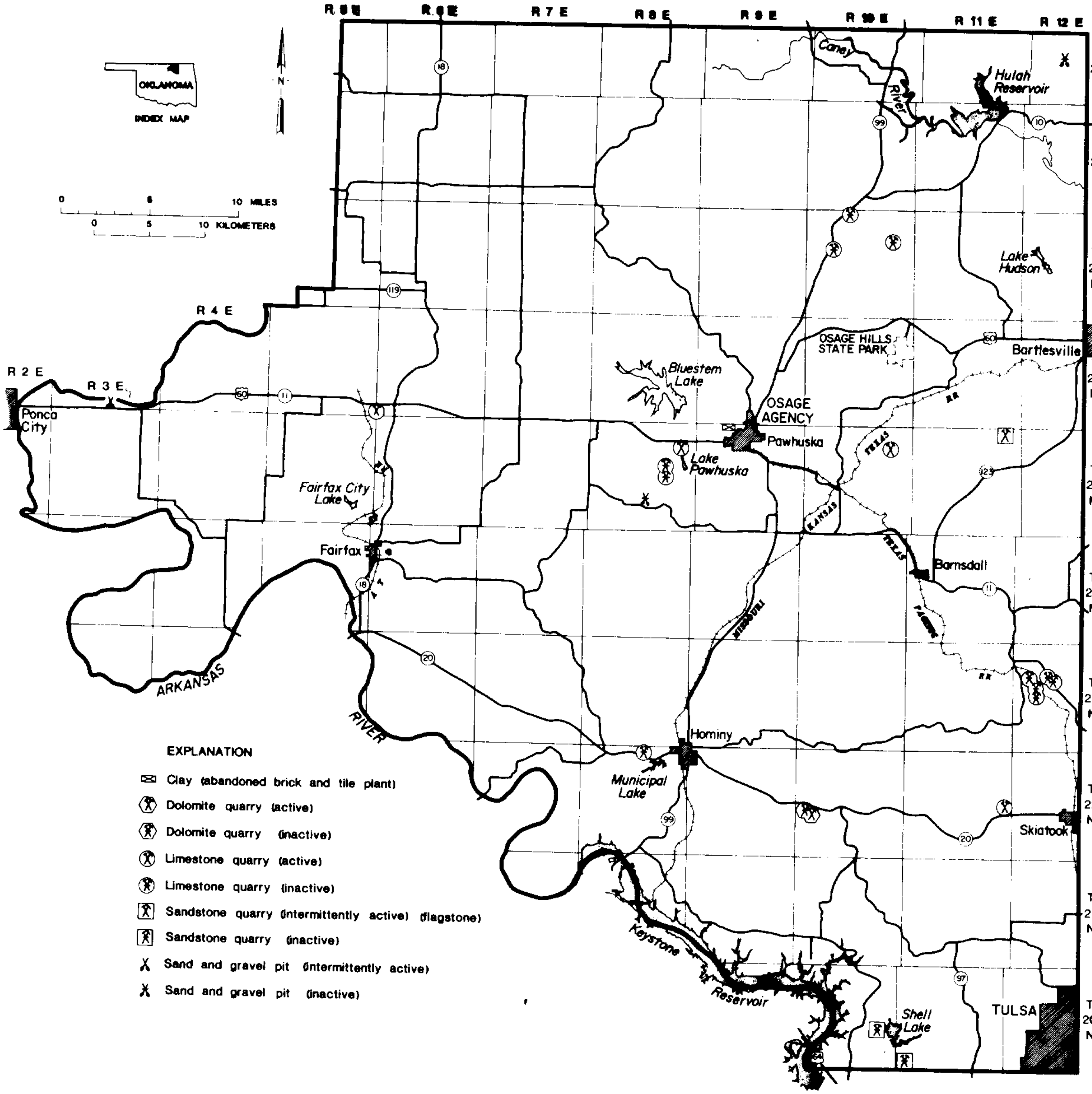

Figure 19. Map of nonmetallic mineral deposits on the Osage Indian Reservation.